RADIO and ELECTRONICS

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THE "RADIO AND ELECTRONICS" DIGEST OF CIRCUITS:

We regret to inform readers that, owing to circumstances connected with the printing of the "Digest," we are unable to publish it this month, as was originally scheduled, so that it will unfortunately not make its appearance before August.

OUR COVER:

This month's cover illustrates one of the most compact pieces of electronic equipment ever produced. It is a radar set for carrying in aircraft which have insufficient room for stowage of the gear inside the fuselage. The set was constructed to go into a bomb-shaped container similar in appearance to a jettisonable petrol tank. The only part of the whole equipment that is inside the aircraft is the indicator C.R.T., which can be seen in its case, and with its eye-shield, at the right side of the photograph. The rotating parabolic aerial reflector can be seen at the nose of the unit.

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TELEVISION IN NEW ZEALAND

From time to time in these pages the question of television crops up, so that readers may be pardoned for asking if it has become a hardy annual! This is precisely what it is in many quarters, and the recent announcement that Australia is to have an organized television system in two years' time brings this problem rather closer to home than it has so far been.

As long as three years ago this journal expressed the opinion that it would be several years at least before a television service would be established in this country, and so far events have borne out this forecast. It is clear from the published reports that those interested and responsible in Australia have gone much farther along the road to providing a service than have similar authorities in New Zealand. In fact, before it was possible to announce that a service was projected and to be in operation in two years' time, considerable preliminary work must have been done in Australia. This is all the more apparent because the reports state that the technical standards for the service have already been decided upon, and this is an aspect upon which a great deal of expert deliberation must have been done, together with much exploratory work among existing systems in America and England before any decisions could be reached. All that appeared in the New Zealand Press was the bald statement that 625 lines would be used, but a correspondent in Australia informs us that, as one would expect, all the other relevant standards have been fixed as well.

In Australia, the official announcement will no doubt be greeted with considerable satisfaction by the radio industry as a whole. There the industry has suffered for some time from the public misapprehension that television was only a short time away, with obvious unfortunate repercussions on the domestic-set market. Here, since the war, there has been a certain amount of the same trouble, but not nearly to the same extent. However, unless something is done, there will clearly be a slump in the radio-receiver business here, owing to the same public attitude. The public themselves—and even the daily Press—can hardly be blamed, because television is news, and the papers are hot after it. The announcement of the coming of television in Australia and that of an English company's intention to give demonstrations throughout this country later this year can only whet the public appetite and create the impression even more strongly that television is "just round the corner." There are many arguments for and against an early setting-up of a TV service here, but these are relatively unimportant at the moment. What the radio industry needs is an official announcement of television policy from the Government. This should state, quite unequivocally, the number of years within which it is expected that a service will be set up, and should point out that, even when it is, there will never be any question of its affecting the normal broadcasting system. Thus, the public could be given something definite to go on, and also the knowledge that the coming of television will not mean the outmoding of their ordinary sets. Such a statement would be only fair to the radio industry, which the Government has been at pains to foster, but to which, having done so, gives no assistance in matters like this where some real planning could have very beneficial results. The main trouble is that there is every reason to doubt that the Government has a policy, or is in the process of formulating one.

The radio industry will without doubt be very pleased when TV does arrive, because it should give a considerable fillip to a difficult business; but, if nothing is done about this new service, which is bound to come sooner or later, then we will possibly be treated to the spectacle of the radio industry being caught "on the hop" by a snap announcement at some future date that the Government has at last decided to install a system. Both the Broadcasting Service (who will no doubt provide the service when it does arrive) and the manufacturers (who will have to provide the receivers) should now be occupied with long-term plans. Both will need to send personnel abroad for practical experience before embarking on any programme, and both will need to do much developmental work before either is ready to say, "We will start on such-and-such a date," even if that date is two years away, as in the Australian case. We have a first-class chance to start work now on the ordered development of television in this country, and it is up to the Government to give a lead. The answer does not need to be a positive one. It might well be an unqualified "No" for a period of so many years. The important thing is that all the implications should have been considered, and that a definite decision—understandable and, indeed, unmistakable in its meaning—should be given to the public. If it is not, the radio industry may find itself in considerable difficulties through no fault of its own.

A VERSATILE TONE-CONTROL CIRCUIT

This article shows a number of basic circuits that can be used for obtaining bass boost or attenuation and treble boost or attenuation. Only condensers and resistors are used, and a complete circuit is shown which enables all these functions to be combined and controlled by only two potentiometers. The circuit is capable of being incorporated in any audio amplifier.

INTRODUCTION

The ideal reproducing system is one which requires no controls by which the response to various frequencies in the audio band can be altered, and yet which enables anything to be reproduced with the utmost realism and fidelity. Needless to say, no such system has yet been evolved, and, even if it had, it would not be a practical proposition to use, because of imperfections in parts of the reproduction chain over which we have no direct control. We refer to gramophone records themselves, and to radio programmes. These we have to take or leave as we find them, and, although the people responsible for producing them do their best, the results are as yet far from perfect. True it is that in general, the best records and radio transmissions have a fidelity that is much better than the bulk of the reproducing equipment, by way of radio sets and gramophone reproducers, that is in the hands of the public. However, we are not talking about this at the moment. What we have just said is that as long as imperfections exist in recordings and radio transmissions, however slight they may be, a "perfect" reproducing system would not give us a perfect result. This being the case, it is more or less useless to strive for a perfect reproducing system that needs no manual control over such matters as the frequency response. In fact, the situation now exists where, by spending enough money on our reproducer, we are able to get from transmission and recordings just about as much as is on the best of them, and a good deal more than the poorer ones are able to give us. This is, in one way, unfortunate, because it often means that poor material sounds worse the better the reproducer is that is handling it. This being the case, it is still necessary to provide some means in the amplifier for cutting down or raising the frequency response at either end of the scale. In other words, we need our old friend (or bugbear, according to taste), the tone control. By tone control we do not mean what was once described as "an inexpensive device for covering up bad design," but a comprehensive system of response compensation, designed to work with an amplifier-speaker system of as good characteristics as possible.

We would like to emphasize that in adding such a tone control we are not trying to compensate for deficiencies in the reproducing system proper, but to improve results that are obtained from poor or deficient reproduced material.

In doing this we have to take into account several facts—

(1) Gramophone records are frequently found to be deficient, either in bass or treble response.

(2) Records also suffer quite frequently from very high surface noise. This can be at either end of the frequency scale, and takes many forms. At the top end, it is usually excessive scratch, while at the lower end it is usually a case of rumble and other low-frequency noises caused by poor recording.

No. (1) above obviously gives us a need for both bass and treble boost for our tone-control circuit, while No. (2) shows the necessity for both bass and treble cut, or attenuation. Of course, it is necessary to have complete and separate control of all four functions, and if separate controls were to be used for all, the whole arrangement would be more cumbersome than useful. However, it is possible to have

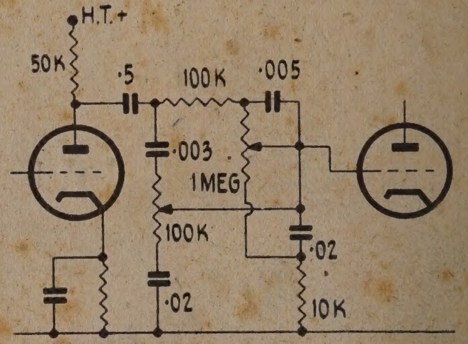


Fig. 8.—This circuit gives independent control of high and low frequencies with only two potentiometers to give bass boost or cut. It should be used to follow a triode amplifier, as early in the circuit as possible.

a circuit in which two potentiometers do the four things needed, and this makes an easily workable system, which can give any desired combination of bass boost or cut with top boost or cut. Towards the end of this article we present a circuit that was developed by E. J. James, and described in the "Wireless World" early this year. It is such a useful circuit, and one that so many of our readers can be expected to need, that we have prepared this article about it, at the same time giving some general notes about tone-control circuits of similar principle, so that, if readers desire, a system can readily be worked out for performing only some of the things which the comprehensive system will do.

RESISTANCE-CAPACITY TONE-CONTROL CIRCUITS

There are a number of ways in which frequency response can be altered. Chief among them are those which rely on circuits that are resonant, or tuned, and those which rely solely on combinations of resistance and capacity. The former type has the advantage that it can actually give an increase of amplification at certain frequencies, leaving the response at other frequencies unchanged. It has several disadvantages, however, which for most purposes outweigh this advantage. For example, resonant tone-control circuits require the use of inductances as well as condensers, and these are not only impossible to get, unless they are specially made, and if they are, the cost is high. It is possible, but not

very practicable, to wind one's own, the main difficulty being that, once wound, it is difficult to know or to measure at all accurately what their inductance is, unless one has access to laboratory equipment. A further grave disadvantage of tuned circuits is their undoubted ability to pick up hum. If they are iron-cored, as they would have to be for the lower frequencies, this is a very strong objection, which is aggravated by the fact that the earlier they are placed in the amplifier the better, so that the signal level is low and makes hum pick-up more important than it would otherwise be.

As against all these bad points, the resistance-capacity, or non-resonant, kind of tone-control circuit has these advantages: (1) It is very cheap, since resistors and small condensers cost almost nothing; (2) it is not more susceptible to hum pick-up than any other parts of the amplifier itself; (3) its component parts are readily obtainable at all times.

The only real disadvantage to be offset against these good points is that any circuit which uses this system works by producing an actual **loss** at all frequencies except those whose response is to be boosted. In the case of attenuation, of course, the loss takes place at the frequencies concerned. This, however, is not a serious matter at all, since losses can easily be made up for by adding extra amplification. In most cases this should not mean more than one extra stage of amplification, compared with the uncompensated amplifier, and this is usually an easy matter to arrange.

HOW R.C. TONE-CONTROL CIRCUITS WORK

Before going on to describe the action of the full circuit that we are about to recommend, it would be as well if we described this sort of tone control in general terms, and gave readers the basic simple circuits from which all other, more complex ones are derived. This should give the reader a general appreciation of how such things behave, and should allow him to work out systems for himself, which is a far better thing than just presenting a complicated circuit, saying what it does, and leaving things at that.

There is a basic R.C. circuit for all four of the necessary functions, and we will begin with the possibilities for bass boost.

The fundamental bass-boost circuit is given in Fig. 1 (a). It consists of two resistors and a condenser. Now, in order to explain its action, it is not necessary for the reader to know anything more than that a condenser acts in these circuits as though it was a resistor, whose value varies with the frequency of the signal passed through it. We can regard it in this way because we are interested only in the size of the voltages passed at various frequencies by the circuits, and not in their phase, which is

a matter which needs full A.C. theory to describe. So does the amplitude (or size) if we are to work out the performance of a network in full, but here we will content ourselves with looking at the behaviour at very high and very low frequencies. This will give us all we want to know about what to expect. We said above that the condenser can be regarded as a resistor whose value depends on frequency. So we can, but it is essential to know also that the higher the frequency is, the smaller the "resistance" offered by the condenser. Thus, for any condenser, irrespective of size, we have that at very high audio frequencies it acts as though it were a short circuit, while at very low ones it acts like a very high resistance, or open circuit.

With this idea in mind, let us look at Fig. 1, and see if we can work how it operates with regard to different audio frequencies.

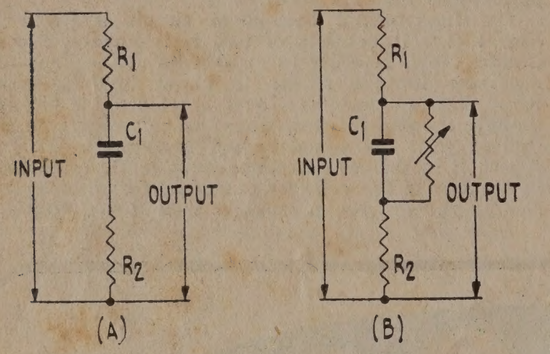


Fig. 1

First of all, let us imagine that we have a single very high audio frequency passing through. The condenser in this case can be looked upon as a short circuit, and will therefore simply act as a connection between the lower end of R_1 and the upper end of R_2. These then act as a voltage divider, and the output voltage is a certain fraction of the input voltage for all high frequencies, at which C_1 can legitimately be regarded as a short circuit. Just what fraction of the input voltage appears at the output terminal will clearly depend on the relative values of R_1 and R_2. Now, at some low frequency, C_1 will no longer look like a short circuit, but will present some reactance, and for the purpose of our simple explanation can be regarded as an extra resistance, R_3, wired in in place of C_1. Thus, the condenser has the effect at low frequencies of adding resistance to the value of R_2, while R_1 remains unchanged. It is plain from this that, at low frequencies, the output voltage will be higher than at high frequencies. Furthermore, the lower the frequency, the more the apparent resistance added to R_2, and the greater the output. Thus, the whole effect of the circuit of Fig. 1 (a) is to cause a certain amount of fixed attenuation to decrease gradually at frequencies lower than some particular one which is determined by the value of the condenser.

There are a number of simple conclusions that arise from the above description of the action of the basic bass-boost circuit. The first is that the circuit really acts, not by actively boosting anything, but by leaving the extreme low-frequency response unchanged, and progressively attenuating frequencies higher than this, until a stage is reached where no further attenuation occurs, so that thereafter the response is flat. This description clearly tallies with that of a response curve which is flat at middle and high frequencies, and rises at low frequencies. In other words, this is bass boost.

Another important point that is well worth remembering is that the maximum boost attainable depends on the actual amount of attenuation that the circuit causes at middle and high frequencies. For example, suppose that R_1 is 20k. and R_2 is 180k. Then, at frequencies where the condenser no longer has any effect on the response (i.e., high ones), the output must be one-tenth of the input voltage. Thus, the middle and high frequencies are attenuated by 10 times, or 20 db. At very low frequencies there is no attenuation at all, so that effectively we have a maximum bass boost of 10 times, or 20 db., **and this figure is dependent solely on the values of R_1 and R_2.** This is a most illuminating fact, because it applies not only to this, but to all R.C. tone-control circuits. The amount of the greatest boost (or attenuation, as the case may be) depends solely on the resistors in the network, and not on the condensers at all.

What, then, does the condenser do in determining the characteristics of the circuit? Here, again, the answer is very simple. **The condenser only determines at what frequency the boost shall start.**

CONTROLLING THE BOOST

It will have been noticed that the circuit of Fig. 1 (a) has no variable elements, and so whatever boost it gives cannot be controlled from the front panel. This is a serious disadvantage for our purpose, but fortunately it can be removed by a simple modification to the circuit. The modified circuit is shown in Fig. 1 (b), where it will be seen that the only change is the addition of the variable resistor. This acts in the following way. When it is adjusted so that the resistance in circuit is zero, then it has short-circuited the condenser, so that the effect of the latter must

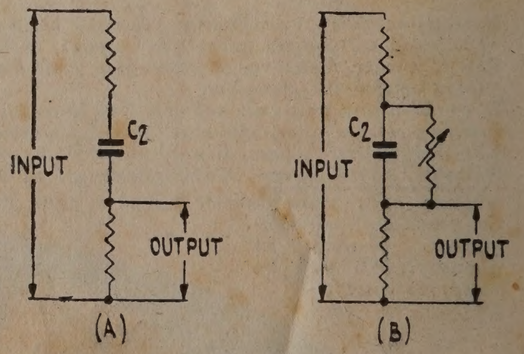


Fig. 2

be nil, and no boost can occur. All that remains, in the practical sense, is the voltage divider R_1 R_2, **which now acts in the same way at all frequencies.** The response is therefore flat with the resistance in this position, and the boost is removed. An interesting and useful point about this circuit is that when the condenser is short-circuited, and the response is flattened, the output voltage at all frequencies is brought down to the same as occurs at middle and high frequencies when the boost is active. Thus, working the boost control has no noticeable effect on the apparent volume of the main

body of sound, which is not in the region being boosted.

Having described Fig. 1 in some detail, we can go on and have a look at some of the other circuits.

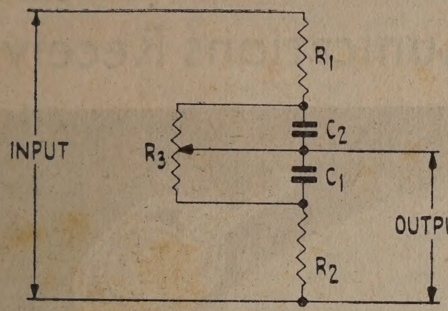


Fig. 3

BASS ATTENUATION

The fundamental circuit for bass attentuation is given in Fig. 2 (a). Here, we have the same arrangement of resistors and condenser as in Fig. 1, with the sole exception that the output is taken from across R_2 instead of across R_2 and the condenser. Here, we have a certain fixed attenuation at middle and high frequencies, because, as before, the condenser can be regarded as a short circuit at these portions of the audio range. C_2, the condenser, now adds more and more resistance in series with R_2, in the same way as before, the lower the frequency, but because of the place at which the output is taken, the output this time becomes less and less the lower the frequency.

As before, the amount of effect of C_2 can be varied by placing a variable resistor across C_2, so that when this variable resistor is at zero resistance, the condenser is shorted, and the response is flat. Also as before, when the shunt resistor is at its maximum value, it can be regarded as open-circuited, so that the full effect of the condenser is felt. This position therefore gives maximum cut, as in the previous case it gave maximum boost.

COMBINING BASS BOOST AND CUT

Fig. 3 shows an ingenious method for combining the circuits of Figs. 1 and 2, and is able, with the one variable control, to give boost, cut, or no effect, depending on where the slider is set. On Fig. 3, the resistor and condenser numbers correspond to those on Figs. 1 and 2. This time, the potentiometer, R_3, combines the functions of the two variable resistors in the separate diagrams. The upper part of the potentiometer, above the slider, represents the variable resistor in Fig. 2 (b), while the lower portion represents that in Fig. 1 (b). Let us see what effects R_3 on Fig. 3 has when at its extreme positions.

When the slider is at the top of its travel, it short-circuits C_2, and so the circuit reduces to that of Fig. 1 (b). Since the value of the potentiometer is high (say, 1 meg.), it can be regarded as an open circuit, and the circuit reduces still further to that of Fig. 1 (a). In this position, therefore, the effect of the circuit is to give its maximum bass boost. At the other end of the scale, the slider of R_3 short-circuits C_1, and the arrangement is exactly the same as that of Fig. 2. This position of the control therefore gives maximum bass attenuation, or cut. Now, since the potentiometer gives a smooth variation in resistance, there must be a gradual transition from the condition of maximum bass boost to that of greatest bass cut, as the slider moves from the top to the bottom of R_3. It is therefore only reasonable to suppose that there must be some intermediate position of the control where the effects of the condensers are equal, the result being a flat response, without either boost or cut. This in practice, is found to be the case. It is not difficult to see why this works out so, when it is remembered that a voltage divider which consists of two voltage dividers in parallel, one of condensers and the other of resistors, can have an equal response to all frequencies. If the condensers are fixed in value, as here, this condition holds when the ratio of the resistors is the same as the ratio of the condensers' reactances. Since the ratio of the two resistances goes through all possible values when the slider is moved from one end of the potentiometer to the other, there must be some spot where the ratio is correct for giving the double voltage divider that has a response independent of frequency.

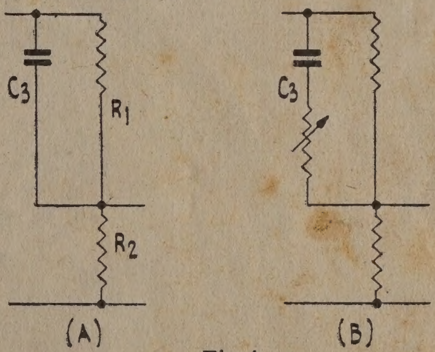


Fig 4.

The circuit of Fig. 3 is quite a practical one, and can be used as a coupling network between two valves in an amplifier. A blocking condenser would be used in the input lead, of course, and the grid of the second valve could be directly attached to the lead labelled "Output." Suitable values would be R_1, 100k.; R_2, 10k.; R_3, 1 meg. pot.; C_2, 0.005 μf.; and C_1, 0.02 μf. Note that the plate coupling condenser from the previous valve should be a large one, not smaller than 0.5 μf., if the boost is to be fully effective.

FUNDAMENTAL CIRCUITS FOR THE TREBLE END

We have now dealt completely with the bass end of the scale, and can pass on to the circuits that give treble boost and attenuation.

The basic top-lift arrangement is that of Fig. 4 (a). Here again we have two resistors and a single condenser, but the arrangement of them is somewhat different from that of Fig. 1 (a), as might be expected. The best way of predicting its performance is that used above for describing the action of the previous circuits. At very low frequencies, C_1 acts as though it were a resistor of very high value, and in the limit (i.e., at zero frequency) it can be looked on as an open circuit. The output of the network is thus determined, at very low frequencies, by the voltage dividing ratio of R_1 and R_2. At high frequencies, however, C_1 looks like a smaller resistance (and, as before, the higher the frequency the

(Continued on page 39.)

THE RADEL INTER-COM.

Many radio men and others with home workshop facilities feel the need for a simple inter-communication set for talking between the workshop or shack and the house. We have therefore designed a straightforward system with two stations, served by a single amplifier. It gives two-way calling, and can easily be modified to include three or more stations by adding a selector switch at the master station and only a switch and speaker for each extra station.

INTRODUCTION

The "intercom." set, as it is colloquially called, is a very versatile and useful instrument, as those in many offices and factories have found. Commercial intercom. systems have been developed to a very high degree of efficiency, and are capable of extension to almost any required degree of complexity. However, for a multitude of purposes about the home or small business premises, a simple system that can be built and installed by anyone with a little radio knowledge can be made to fulfil all major requirements. We do not intend here to outline all or even many of the multitudinous uses for such a system, for the important thing is that many radio men, professional or amateur, will have their own requirements, and will only require a suitable design in order to start construction at once. The obvious use of such a set in the home is where a workshop or shed is some distance from the main part of the house—a situation where a simple two-way intercom. can save endless running about or lung-straining in order to effect communication by solely natural means! There are even some very unconventional but none the less useful applications for the intercom. set; one use to which the writer has seen it put is that of an electrical baby-watcher! This is not quite so ridiculous as it sounds when the infant is in a room some distance from the living-room, and its parents cannot hear any distress signals it might put out without going out in the cold to listen!

FEATURES OF THE RADEL INTERCOM.

As we said previously, we can quite easily leave to the ingenuity of readers the question of how they could put an intercom. set to work, so that we will proceed to describe the functioning of this particular one, and readers may judge whether, in its original form, it will suit their own needs.

The circuit we are about to describe makes provision for two stations only. Simple additions, however, will enable the same basic system to be extended to have as many stations as may be desired. Apart from the amplifier, which is common to both (or all) stations, and which resides at one of them, each station consists only of a small permanent magnet speaker and a talk-listen switch. For the time being, we will not consider the question of extra stations, but confine the discussion to the simple two-station arrangement that will be quite enough for the majority of purposes.

Each speaker has its talk-listen switch, and either of them can initiate a conversation. It would be possible to design a slightly simpler arrangement in which a conversation could be initiated only from one of the stations, but the usefulness of the added facility of being able to call from either end was felt to more than justify the slight amount of extra wiring needed. For one thing, we have no desire to put into the hands of wives a totally unfair scheme whereby they can talk, say, from the kitchen to the unfortunate male in his hide-out with no possibility of being answered back! It was felt that this might not exactly find favour with the said male, who, after all, has the trouble of building the set. Seriously, however, the system in which a call can be started from only one end is not nearly as useful as the system used here.

The wiring between the two stations is quite simple, and calls for only two wires, one of which must be shielded. The shield acts as the earth return, so that we really have the same thing as a three-wire, two-channel line, with a common earth return. However, the requirements of the intercom. are such that one of the signal wires must be shielded from the other. Thus two wires, one of which is shielded, effectively give two complete circuits—one for listening and the other for talking. Perhaps we should mention what will be self-evident to many—namely, that each speaker is used as both microphone and loudspeaker, though not, of course, simultaneously.

The talk/listen switches are of the push-button type which have a spring release, so that both speakers dwell in the "listen" position until either switch is pressed. When this is done, the speaker whose switch is depressed becomes a microphone, and its output is applied to the remaining speaker. After the one initiating the conversation has said his piece, he releases his switch, which returns the speaker to the "listen" position, whereupon the party at the other end presses his own switch enabling his speaker to act as a mike to feed the other speaker. Of course, push-button switches are not imperative, since any switch that will return automatically to its normal position can be used. In fact, a self-returning switch need not be used if it is desired to make use of an ordinary two-position switch which does not return of its own accord, but this means simply that the operator has to work the switch both ways instead of allowing the switch itself to do the work for half the operations. The amplifier has to be on all the time the intercom. is wanted to be in use, since, otherwise, the end at which the amplifier resides would have complete control. However, a small amplifier is used, which takes little power, and the cost of running the amplifier for long periods is very slight.

PROBLEMS IN CONNECTION WITH INTERCOM. SYSTEMS

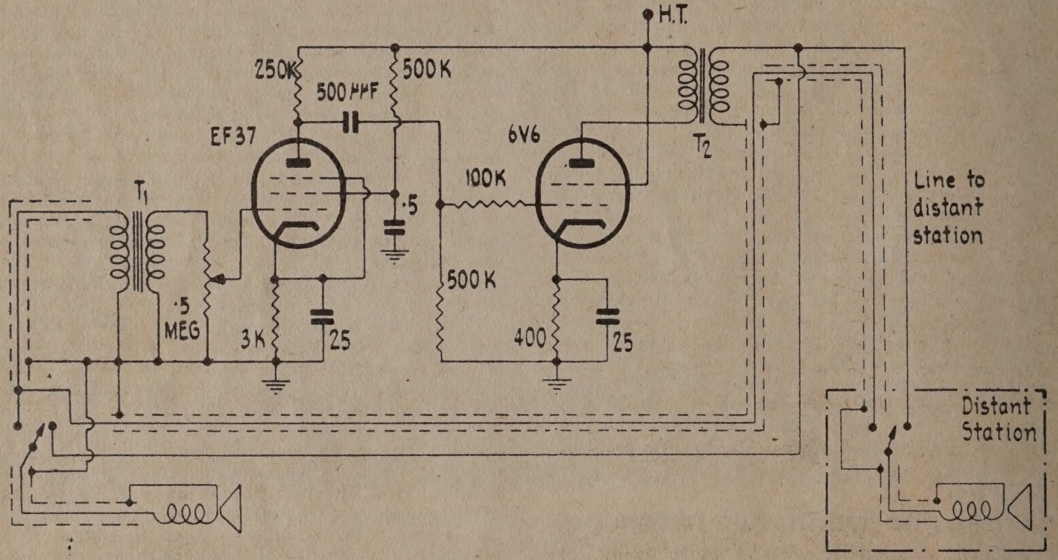
There are many who have tried to build a simple intercom. being under the impression that it is a very simple matter indeed, and who have failed to get good results. The view that the intercom. is just "another audio amplifier, with a bit of wiring thrown in" is far from true. This does not mean that there is anything at all difficult about building one if the job is gone about in the right way, for there is not, but there are certain requirements which must be fulfilled if success is to be attained. In a system of this kind, the main difficulty is that of feedback, since the input and output of the amplifer are con-

nected to the switch so that the speaker may be switched from the input to the output of the amplifier for talk/listen operation. This can more readily be appreciated on reference to the circuit diagram, and we will have some more to say about this when discussing the detailed arrangements. Be it said, however, that it is feedback that is probably responsible for 90 per cent. of the troubles associated with poor performance in the "home-brew" variety of intercom. set. In many cases, operation from one station is quite satisfactory, but at the other a feedback occurs unless the amplifier gain is cut down to such an extent that the volume at the first station is not great enough for practical working. There are varying degrees of this trouble, depending on how much feedback is occurring, and therefore how much the gain has to be reduced before the system operates without howling. Sometimes it is the station at the amplifier end that cannot receive without a feedback howl, and sometimes the distant station is similarly affected. In either case the trouble is due to improper connections of earths. This is a point which is often missed, especially by amateurs, since one tends to think that the only gear that suffers from earthing troubles is radio frequency equipment. This is not so at all, and in the section on construction we will show how proper earthing should be done so as to eliminate feedback.

Another simple fact that is often forgotten, and which can be the cause of poor reproduction is that small speakers are not meant by their designers to act as satisfactory microphones. The main result is that if ordinary values are used in the audio amplifier coupling networks, the low-frequency response is too great when the speaker is used as a mike, and the speech sounds muffled and "woofy." This can be very simply overcome by using small coupling condensers and grid leaks in the amplifier, and even by using output and input transformers with low primary inductance. The lower register, below 200 c/sec.., is thereby much attenuated so that, while nothing like high-fidelity speech is attained, the results are at least clear, crisp, and very intelligible.

The other important point to be remembered is reliability. In general, an intercom. set can be expected to be on for long periods at a time, and for at least six days a week. It is essential, therefore, that only the best parts be used, so that as few breakdowns as possible shall occur. Here, we have gone to some pains to secure trouble-free operation, as will become clear when we discuss the circuit in detail. Nothing is worse than a "facility" that is far from facile, through frequent breakdown, and which cannot be relied upon to work when called upon.

A point worth remembering here is that equipment that is in continuous operation should be arranged so that it does not run too hot. Carbon resistors should be generously rated, and on no account should over-voltages be applied to the valves. If extra special reliability is required, high-voltage electrolytic condensers should be avoided, and oil-filled paper ones used instead.



Circuit of the intercom. unit. No power supply has been shown, but this can be a simple affair with a single-section filter. It is discussed in the text.

THE CIRCUIT IN DETAIL

First of all, let us have a look at the amplifier. This is a quite straightforward affair of two stages, resistance-coupled to each other, and with transformers at input and output. T_1, the input transformer, is an ordinary output transformer, used as a microphone transformer. It can be identical with the output transformer, which should match a single 6V6 to the voice-coil impedance of the speakers. The latter should be identical for best results, otherwise one of them cannot be properly matched to the amplifier output. Needless to say, T_1 is used backwards. That is to say, what is normally the secondary is used as the primary. This need cause no confusion, since this means that the voice-coil winding is connected on the speaker side of the circuit, and the winding that is normally the primary is used in the grid circuit side. T_1 acts simply as a voltage step-up device to increase the signal from the

speaker when it is used as a microphone. The volume control consists of a 0.5 meg. potentiometer connected across the grid winding, with the grid taken to the moving arm.

In order to cut the low-frequency response suitably, and eliminate boominess and woolly reproduction, the coupling condenser between stages is reduced to the low value of 0.0005 μf. This also enables a mica condenser to be used, with consequent possible improvement in reliability.

An EF37 is used as the voltage amplifier, as this type is specially designed to have low microphony and to be quiet in operation. This is particularly important if it is decided to put the speaker for the station at which the amplifier is located, inside the amplifier cabinet. In this case, mechanical vibration of the voltage amplifier valve must be avoided, and this is difficult to do in a compact unit when the speaker is very close to the valve in question. The output stage uses a 6V6, but by no means makes use of the maximum possible output of this valve. The available power output is much reduced by over-biasing it with a 400-ohm cathode resistor. The normal cathode resistor is 250 ohms, and with an H.T. voltage of 250, this gives the 6V6 an output capability of 4.5 watts. Here, the total amplifier drain is reduced from the normal 50 ma. for the 6V6, plus 1.5 for the EF37, to 30 ma. for the pair. This represents a considerable saving of H.T. power, with less heat being dissipated in the amplifier, and with a much reduced power output. However, this is no disadvantage at all, since nothing like 4.5 watts is needed, or desirable, for a 3 in. speaker. This size of speaker is used because it makes a rather better microphone than a larger one, and also so as to reduce the size of the speaker cabinet, which can be quite minute with a 3 in. speaker. The reduced power output of the 6V6 allows a small power transformer to be used if desired, or else a 60 ma. one to be used at half the rated load, for extra reliable operation and small transformer heating. A further saving is that a small 30 ma. choke can be used in the smoothing circuit if desired.

Apart from these points, there is little of note in the amplifier itself—at least, as far as the circuit diagram is concerned. Perhaps we should mention the 100k. grid stopper in the 6V6 stage. This is a worth-while insurance against amplifier oscillation, and should be included. It also helps in case there is a tendency for the whole system to oscillate at a fairly high frequency.

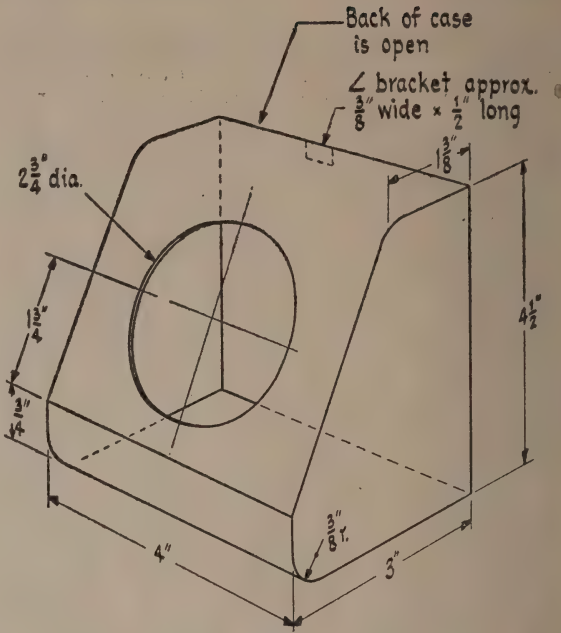
No power supply has been shown, but this can surely be left to the imagination of individual constructors. A suitable arrangement would be a 280-volt-a-side 60 ma. power transformer, and a 6X5 rectifier, with a smoothing filter consisting of a 60 ma. choke in a condenser-input filter circuit. The input condenser should be 8 μf., and the second one can have as high a capacity as may be wished. There will in any case be little likelihood of hum trouble, since the low frequencies are well attenuated, and hum will not show up readily in the speakers because of their small size and minute baffles. If the greatest possible reliability is desired, it might be better to use an 80 or a 5Y3 as the rectifier, because there is slightly more likelihood of rectifier failure with the 6X5.

The amplifier disposed of, we had better say a few words about the inter-station wiring and about the earthing system to be used to avoid feedback.

INTER-STATION WIRING

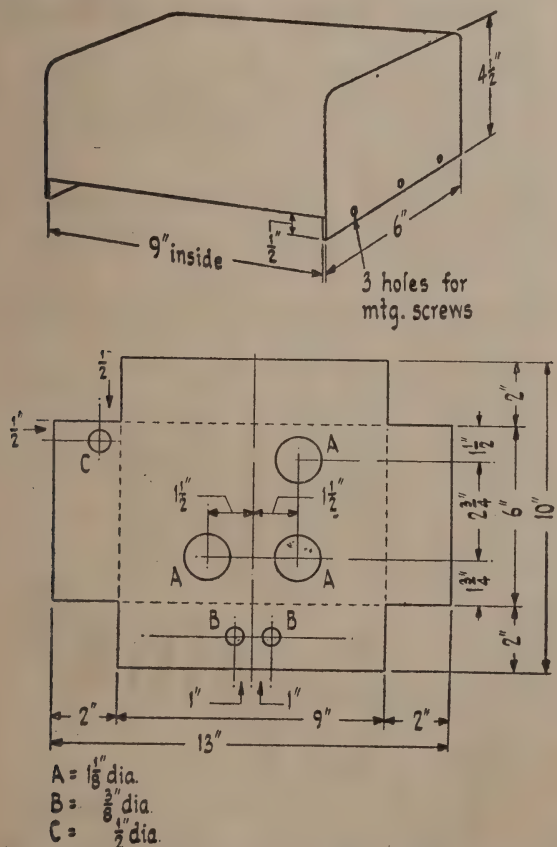
For a start, it should be mentioned that both switches have been drawn as they appear in the resting condition of the intercom. That is to say, both speakers are connected thereby to the amplifier output, in readiness for a call. Thus, if either station presses its talk/listen switch, the other speaker remains connected to the output of the amplifier ready to receive the signal. Before describing the earthing in detail, it may be said that one side of the output transformer and one side of each speaker voice-coil is earthed to the chassis, through the shield-braid of the wiring that is connected to the input transformer. The latter also has one side of the primary earthed, so that, apart from the common earth connection, only two wires are needed to carry input and output signals. Because of this, only a single-pole change-over switch is used at each station, for only one voice-coil lead has to be switched. It will be seen that the "hot" end of the output transformer is connected to one contact on each talk/listen switch. The "local" station (the one at which the amplifier is situated) has this connection made within the chassis, unless the local speaker is given a cabinet separate from the amplifier chassis. In this case, the output lead is extended outside the amplifier cabinet to where the talk/listen switch resides. This will usually be one the speaker cabinet, but it may be in a separate small switch-box, if desired. It will be seen that the output lead is not shielded at any part of its run. This is in order because the leads which go to the input transformer are comprehensively shielded.

The second poles of both switches are connected together by shielded wire which runs from the input



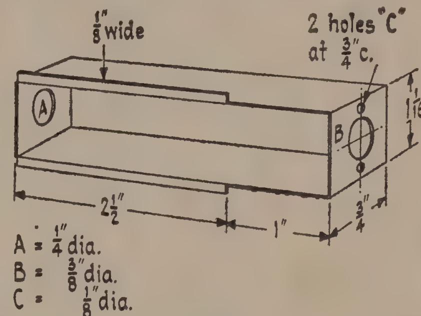
A suitable speaker cabinet for a 3 in. speaker. It can be mounted in the way illustrated, for standing on a desk, or can be inverted for hanging on the wall, in which case it points downwards for ease of speaking into.

transformer at the local station, to the switch at the local station, and thence to the vicinity of the output transformer, from where it goes off to the distant station. The portion of this run which goes between the input and output transformers is inside the amplifier chassis, AND IS INSULATED FROM THE CHASSIS EXCEPT AT ITS INPUT TRANSFORMER END. This is most important, and it is here that improper connection of the earths can cause trouble. More of this anon. It is clear from this that whichever station presses the talk/listen switch will disconnect its speaker from the output line and conect it to the input line. A little consideration will show why the input line must be shielded from the output line. It is because, whichever station is talking, the output voltage of the amplifier appears on the output line, and so, if the input line were not shielded from it, the capacity between the two lines would allow output voltage to be fed back to the input of the amplifier, which would oscillate.



A suitable chassis for the amplifier, with, above, a cover which attaches to the sides of the chassis. If desired, the cover can have ventilation louvres in the sides. There is space on the chassis for the power supply.

The above description completely describes the inter-station wiring, and shows just how simple this really is. The actual installation of the wiring between the stations is further simplified if special intercom. wire is used. This has one shielded and one unshielded conductor, which are enclosed in a cotton braid covering, so that the whole appears and handles like a single wire. This is well worth installing, if only for the look of the finished job and the ease with which it may be handled. On the diagram, the distant station has been shown as consisting of the speaker and switch in one box, but it is not necessary to keep the two parts together. All that needs to be done is to install the switch in a small box of its own and to run the speaker leads to it. The same thing can be done at the local station, thus making three units. The amplifier can be placed out of sight under a table, or on a shelf,; the speaker can be placed where convenient for speaking into, but out of the way of other things; while the switch can be placed ready to hand for ease of operation. It is best, when this is done, but not essential, to shield the leads to the speaker, since the input and output wires only go as far as the switch.



A switch-box suitable for mounting a push-type self-returning switch for push-to-talk, in a handy position away from the speaker. If desired, of course, the switch may be placed in the speaker cabinet.

ARRANGING THE EARTHS

It will be noted that on the circuit diagram **the only earths are those on the amplifier itself, and the braid earths near the input transformer and EF37.** That is, the shield braid of the input leads are connected together and earthed at one point only, which is the common earth point at the input of the amplifier. In the diagram, the secondary of the output transformer is not earthed directly at the output transformer, and this is most important. The line from the distant station is used to earth the output transformer secondary, as the digram shows, and it is essential that the shielded wire shown as going between the output transformer and the input end of the amplifier should be insulated from the chassis except where the earth connection is made. If the earths are not arranged in this way, what happens is that the output current flows through the chassis in order to get to the local speaker, which is earthed near the input terminal of the amplifier. This is sufficient to cause undesired coupling between the grid circuit of the EF37 and the output of the 6V6, with the result that oscillation sets in. But if the earths are made exactly as shown in the circuit diagram, there will be no trouble. In order to make the correct earthing easy to carry out, the line to the distant station should be brought into the amplifier chassis beside the output transformer, THROUGH AN INSULATED GROMMET. The earthy side of

the output transformer secondary is attached to the shielding at the transformer, and some P.V.C. spaghetti is placed over the remaining shield braid, so that earthing does not occur until it reaches the input end of the amplifier, where it is soldered to the common earth point for the EF37 grid circuit. This is the only real precaution that needs to be taken, and if it is observed no trouble will occur.

CHASSIS AND CONSTRUCTION

In this article, drawings are given for suitable speaker boxes for 3 in. speakers, for small switch boxes to house the talk/listen switches, which are assumed to be of the push type with spring return. These are low-capacity telephone switches, and are available from war suplus stocks in some retail houses. If these cannot be obtained, on no account should ordinary toggle or rotary switches be used, for these have so much capacity between contacts that feedback is bound to occur if they are used. A possible alternative is to use a wafer switch, which also has a low capacity between contacts, and which, with a little ingenuity, can be arranged to have a spring return by taking out the balls which run in the detent mechanism and arranging a spring to work against the rotation in one direction. The switch boxes will not do for wafer switches, as these are the wrong shape to go in them. If it is not desired to use separate boxes for the switches, and to mount them in the speaker cabinets, no switch boxes will be necessary, and the cabinets as illustrated will be found large enough to accommodate the switch.

The chassis for the amplifier has room also for the power supply, and a suitable cover has been shown. This may look like an unnecessary frill, but dust should be kept out if possible, and a simple cover for

(Continued on page 48.)

A Practical Beginners' Course

PART 33: BUILDING AN R.F. AMPLIFIER ON A SEPARATE CHASSIS

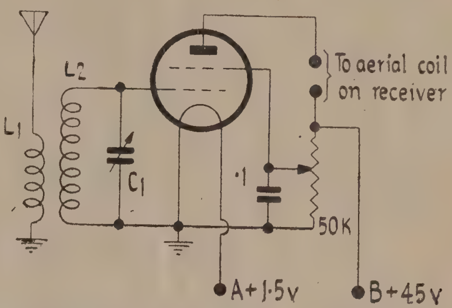
In the last instalment of the course, we described a very simple R.F. amplifier, followed by a crystal detector. This was intended purely as an illustration of how simple an R.F. stage can be, and no doubt many readers have already tried it out. This month we are going to describe in more detail the construction of an R.F. amplifier as a separate unit, which can be attached to any crystal set or regenerative detector. The circuit is given in Fig. 47, and it will be seen that it is almost identical with the R.F. amplifier part of Fig. 46. The main difference is that we have added a means of varying the voltage placed on the screen-grid.

GAIN CONTROL

The purpose of this is to control the magnification, or gain, of the R.F. stage, because we do not always want it to be working "flat out," by any means. One such occasion is when we are listening to one of the local stations, which is quite loud enough to be heard properly without an R.F. stage at all. In this case, the R.F. amplifier is likely to cause more trouble than good, unless we can control its amplification. What happens is that the signal is so large by the time that it arrives at the detector (especially if it is a regenerative one) that the latter cannot handle it without giving a very distorted audio output. This is clearly a thing to be avoided at all costs. It might appear, therefore, that for local stations listening, an R.F. amplifier stage is more of a hindrance than a help, but IF WE CAN CONTROL ITS AMPLIFICATION, there are still advantages that we can make use of. Now, in the last instalment, we said that the R.F. amplifier, added to a simple crystal set or one-valve set, would give us much better selectivity than we can get without it, and this is the big advantage of the R.F. stage for receiving local stations. Whether we use the full amplification of which the R.F. stage is capable or not, we still have two tuned circuits instead of only one, so that the selectivity must be better. This is particularly helpful when we have several local stations on at once and wish to listen to them separately, instead of all together! You will remember that when we were dealing with the various types of crystal set circuit, we gave a number of arrangements by means of which the crystal set, with its single tuned circuit, could be made more selective. Unfortunately, such methods as tapping the aerial down the coil, or using a tapped aerial coil, although they are effective up to a point, finally reach a stage where any further tapping down, or reduction in the size of the aerial coil, results in practically no increase in selectivity, and the only noticeable effect is the weakening of the strength of the signal. When this point is approached, there is no use in trying to continue these processes further.

Another way of tackling the problem is to find a means of adding another tuned circuit, so that the signal has to pass through two selective circuits before being detected. We actually gave the circuit of an experimental crystal set using two tuned circuits, coupled together by a very small fixed condenser. This method is a shade better than the simpler methods used before, and can certainly give much better selectivity, but here again, the addition of the second circuit slightly weakens the very minute signals from the aerial before they can be detected, so that, in order to achieve selectivity, we have to lose some of our sensitivity, and on purpose, too. Now this is a thing that no one likes doing, so that, if there is a third way out by means of which we can get extra selectivity without losing our precious signal strength, we will be far better off.

The R.F. amplifier is the answer, and it is an even better one than the last paragraph suggests, for not only does it allow us to use an extra tuned circuit without losing aerial strength, but it actually gives us an increase in signal strength at the same time.



Circuit of the R.F. amplifier. It can be built on a separate chassis from the set to which it is to be attached in use.

HOW GAIN CONTROL IS ACHIEVED

How, then, do we manage to control the amplification of the R.F. amplifier? It is done simply by modifying the basic circuit of Fig. 46 in such a way that we can control the value of positive voltage fed to the screen grid. This is the purpose of the **potentiometer,** shown in the screen circuit on Fig. 47. The ends of the potentiometer are connected across the B battery. This may not be immediately obvious on inspection of the circuit, but when it is remembered that the negative terminal of the battery is connected to the earthed side of the circuit, it will be so. Thus, when the third connection on the potentiometer is connected to the screen-grid of the valve, it enables the voltage on the screen to be adjusted to any voltage between zero and 45 volts, the maximum voltage of the battery. If the potentiometer is mounted so that its operating shaft comes through the front panel, then it is a simple matter to adjust the amplification of the R.F. stage, just as in a full-sized set one turns the volume control.

It is easy to see that lowering the voltage on the screen-grid must reduce the amplification of the circuit, since, as we saw previously, the screen acts in the same way as the control grid, only not quite so effectively. As the screen voltage is lowered, the plate current decreases, and so do the mutual conductance and amplification factor. With the screen at earth potential, only a very strong signal would be able to force its way through the valve, and the "amplification" would be much less than one.

PURPOSE OF THE BYPASS CONDENSER

It will also be noticed that we have another com-

ponent that did not appear in the circuit of Fig. 46—namely, the 0.1 μf. condenser connected between screen and earth. This is essential if the circuit is to work properly, because one of the things that the screen-grid must not do is to have any signal voltage on it. If it did, it would not act properly as a screen, and would therefore not shield the plate from the grid properly. The result would be twofold. First, the valve would not amplify nearly as well, and, secondly, there would be a strong possibility that the circuit would oscillate, just as a triode R.F. amplifier would do. In the previous circuit, where the screen was connected directly to the battery, the condenser is not needed, because the battery itself acts as a large condenser, and prevents any signal voltage from building up on the screen.

HOW THE SCREEN BYPASS CONDENSER WORKS

It will be remembered that the outstanding property of a condenser is that it allows alternating currents to pass through it freely, but will not allow direct current to pass at all. Now, the plate current of the valve is varying in accordance with the voltage variations placed on the grid by the signal. This goes on whatever the frequency of the signal, and the only difference that the signal **frequency** makes is that the higher it is the more rapid are the variations. Since the screen is at a positive potential, some of the electrons on their way to the plate are intercepted by it, and constitute the screen current of the valve. Now, if no bypass condenser is present, the screen current will vary at the same rate as the plate current. In other words, there will be a screen current component which has the same frequency as the signal, and the result will be that a signal voltage is developed at the screen.

When this happens, the action of the screen is exactly the same as that of the plate proper, and the valve does not act as a screen-grid valve at all. However, if a large condenser is connected from screen to earth, the screen still collects its electrons, which flow as a direct current through the screen circuit, but the variations at signal frequency are not allowed to develop, because for alternating currents the condenser acts as a short circuit. In other words, the screen now behaves in two different ways at once. It is put at earth potential by the condenser, as far as signal currents are concerned, but because the condenser cannot pass direct current, its presence in no way affects the supply of positive screen voltage from the battery. This is a new use for condensers, as far as we are concerned, and one that will meet very often from now on. The other main use, apart from tuning condensers, is to pass signals (A.C.) on to another part of the circuit while **preventing** any D.C. from getting through. Although this sounds different, it really amounts to the same thing, since, in Fig. 47, the signals picked up by the screen are passed on all right, but are returned to earth and thus got rid of, instead of being used.

CONSTRUCTION

The circuit of the R.F. amplifier can be built quite simply on a bread-board, just as the one-valve and crystal sets were built. If we like, we can put a metal front panel on the board, and bring the operating shafts of the tuning condenser and the gain control potentiometer through it, placing a dial and a knob on them, respectively, to make a neatly finished job. Since we will want to work the amplifier on the broadcast band first of all, the coil and condenser can be identical with those used in the crystal set or one-valve set with which the amplifier is to work, as was explained in the last instalment. If the valve set is to be used with the amplifier, there is no need to use separate batteries for the latter, as the battery leads can simply be connected to the correct terminals on the batteries that are already supplying the one-valve set. Note carefully that the output terminals of the amplifier are to be connected to the aerial coil of the detector, whether it is the valve set or a crystal. A most important point to note is that the plate current flows through the aerial coil from the battery to the R.F. amplifier valve, so that it will be necessary BEFORE DOING ANYTHING ELSE to disconnect from earth the end of the original set's aerial coil that was earthed. If this is not done, the B battery will be short-circuited as soon as the amplifier is connected up. The right way of connecting to the aerial coil of the detector is to take the plate of the amplifier to that end of the coil that used to have the aerial connected to it, and after breaking the earth connection, to take the end that WAS earthed, to the positive terminal of the B battery.

The coil for the amplifier, L_1L_2, can be exactly the same as the corresponding windings of the detector coil. Of course, there is no tickler on the R.F. coil, and there will be no need, unless you like, to put taps on the aerial winding, L_1. However, taps can be used if desired, and will still give extra selectivity if it is found that the set is still not selective enough, even with the R.F. amplifier working. If the set to which the amplifier is to be attached has a tapped aerial coil, use the whole of it, as there is no point in tapping the plate down. Needless to say, it is not possible to use this circuit with a set which does not have a separate aerial winding, but uses a tap on the tuning coil for connecting the aerial.

(To be continued.)

LABORATORY PROTOTYPES

Readers who may wish to purchase the laboratory models of equipment described in these pages are invited to write to us for details of prices, delivery, etc. At the moment we have for disposal the original "Junior Communications Receiver" and a completely wired turret-type tuning unit.

For The Serviceman

ALIGNMENT AND CALIBRATION PROCEDURE
6-VALVE DUALWAVE MODEL R.W.

I.F. Alignment:

This month we present two circuits, for the Ultimate 6-valve Dualwave 1948 Model R.W., and the Philips Model 461. Below are alignment instructions for the former.

A signal generator modulated 30 per cent. at 400 c.p.s. is coupled between the control grid of the 7A8 frequency changer and ground, by means of a 1 μf. condenser.

I.F. cores should be adjusted in the following order: Diode core, 7A8 plate core, 7A8 grid core, and 7A7 grid core. The adjustment is made for maximum output at 460 kc/s.

An input of 30 microvolts should produce an output of 50 milliwatts.

Calibration:

Broadcast.—Adjust 1400 kc. point with trimmer T_6 and 600 kc. point with padder T_7. Adjust 1000 kc. point by means of iron core 3. Intermediate points should be checked and oscillator section of gang condenser fanned to correct frequency.

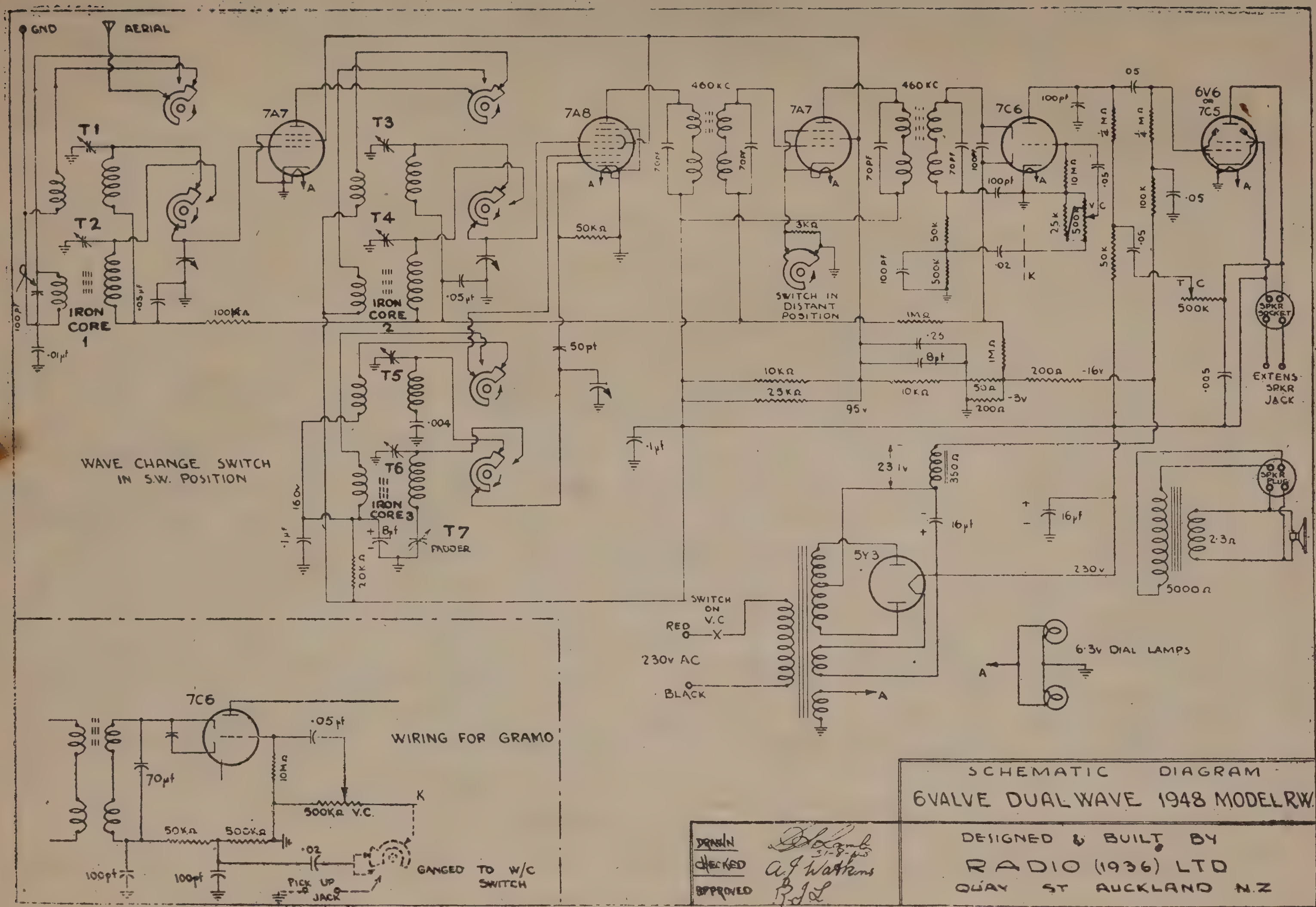
Shortwave.—Adjust 17 mc/s. point with trimmer T_5 and 6.5 mc/s. point by fanning shortwave oscillator if broadcast calibration has been accurate.

R.F. Alignment:

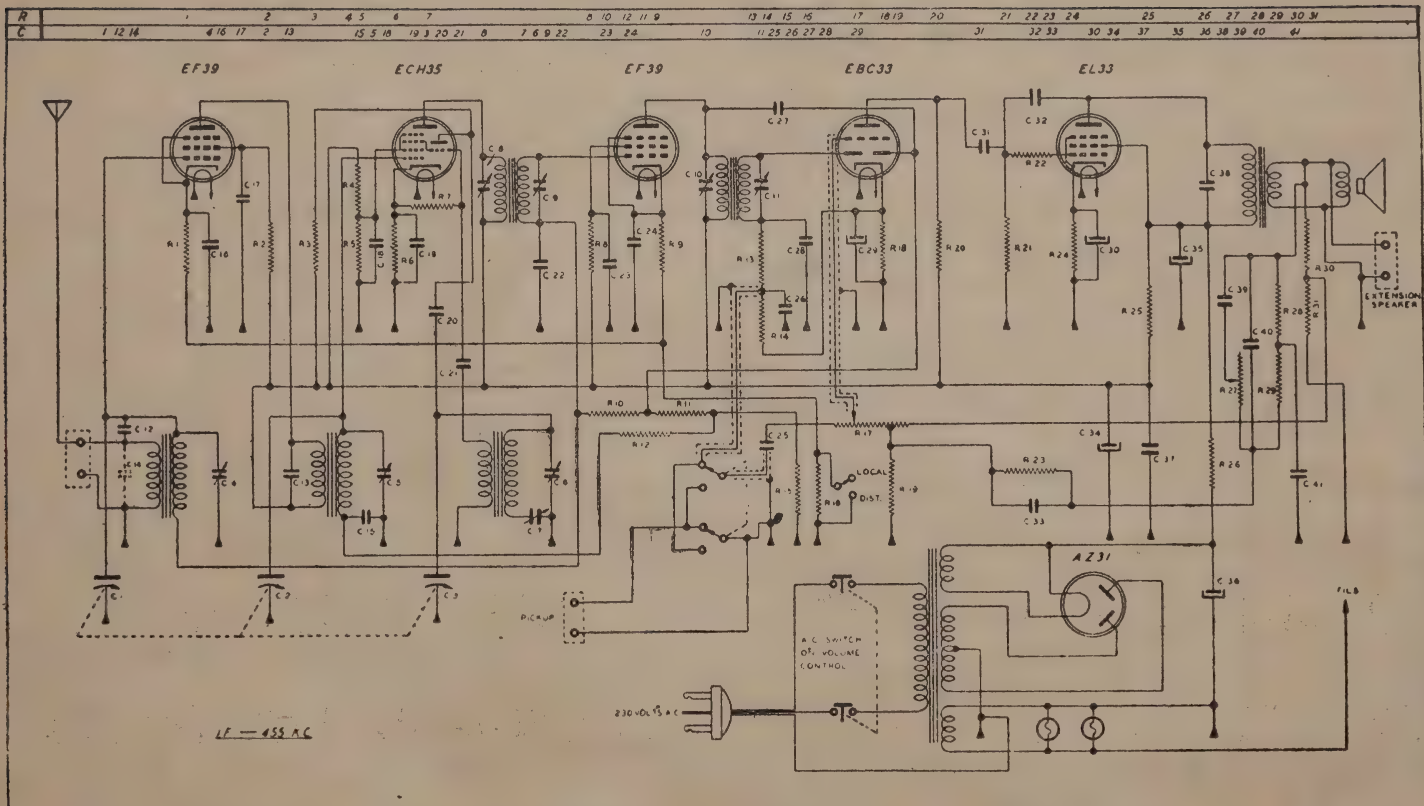
Broadcast.—The signal generator is coupled to the antenna coil by means of a standard dummy antenna. Adjust for maximum output the 17 mc/s. point with trimmers T_2 and T_4, and the 600 kc/s. point by means of iron cores 1 and 2.

If calibration has been accurate, the 1000 kc/s. point should be in alignment. Check intermediate points and connect by fanning detector and antenna sections of gang condenser.

Shortwave.—Adjust for maximum output 17 mc/s. with trimmers T_1 and T_3. Adjust 6.5 mc/s. point by fanning detector and antenna coil inductances.


GND
AERIAL
T1
T2
T3
T4
T5
T6
T7
PADDER
7A7
7A8
7A7
7C6
6V6 OR 7C5
5Y3
460 KC
460 KC
IRON CORE 1
IRON CORE 2
IRON CORE 3
WAVE CHANGE SWITCH IN S.W. POSITION
SWITCH IN DISTANT POSITION
SWITCH ON V.C
RED
BLACK
230v AC
6·3v DIAL LAMPS
SPKR SOCKET
SPKR PLUG
EXTENS. SPKR JACK
5000Ω
2·3Ω
350Ω
231v
230v
95v
160v
-16v
-3v
50KΩ
100KΩ
10KΩ
25KΩ
200Ω
50Ω
1MΩ
500K
WIRING FOR GRAMO
7C6
500KΩ V.C.
GANGED TO W/C SWITCH
PICK UP JACK
SCHEMATIC DIAGRAM
6VALVE DUALWAVE 1948 MODEL RW.
DESIGNED & BUILT BY
RADIO (1936) LTD
QUAY ST AUCKLAND N.Z
DRAWN
CHECKED
APPROVED
A.J. Watkins

PHILIPS MODEL 461



C1, C2, C3 12.5-440 mmfd. tuning cond
C4, C5, C6 3-30 mmfd. air trim.
C7 400-1,000 mmfd. padder
C8 I.F. trimmer
C9 I.F. trimmer
C10 I.F. trimmer
C11 I.F. trimmer
C12 3.8 mmfd. ceramic
C13 100 mmfd. ceramic
C14 4.7-10 mmfd. ceramic
C15 .047 mfd. 400v. paper
C16 .047 mfd. 400v. paper
C17 .01 mfd. 1,000v. paper
C18 .01 mfd. 1,000v. paper
C19 .05 mfd. 400v. paper
C20 100 mmfd. mica
C21 100 mmfd. mica
C22 .047 mfd. 400v. paper
C23 .01 mfd. 1,000v. paper
C24 .05 mfd. 400v. paper
C25 .047 mfd. 400v. paper
C26 100 mmfd. mica
C27 10 mmfd. ceramic
C28 100 mmfd. mica
C29 25 mfd. 25v. electro.
C30 25 mfd. 25v. electro.
C31 .047 mfd. 400v. paper
C32 100 mmfd. mica
C33 .1 mfd. 500v. paper
C34 20 mfd. 400v.
C35 40 mfd. 400v.
C36 40 mfd. 400v.
C37 .25 mfd. 600v. paper
C38 .005 mfd. 1,000v. paper
C39 .005 mfd. 1,000v paper
C40 .0022 mfd. 200v paper
C41 .047 mfd. 400v paper
R1 300 ohms ½ watt
R2 100,000 ohms ½ watt
R3 25,000 ohms ½ watt
R4 25,000 ohms ½ watt
R5 60,000 ohms ½ watt
R6 200 ½ watt
R7 50,000 ohms ½ watt
R8 100,000 ohms ½ watt
R9 300 ohms ½ watt
R10 2 megohms ½ watt
R11 .5 megohms ½ watt
R12 2 megohms ½ watt
R13 50,000 megohms ½ watt
R14 1 megohm ½ watt
R15 1 megohms ½ watt
R16 1,000 ohms ½ watt
R17 2 megohms volume control
R18 2,200 ohms ½ watt
R19 5,000 ohms ½ watt
R20 100,000 ohms ½ watt
R21 .5 megohms ½ watt
R22 56,000 ohms ½ watt
R23 56,000 ohms ½ watt
R24 150 ohms 1 watt
R25 2,200 ohms wire wound
R26 900 ohms wire wound
R27 .5 megohms tone control
R28 1,500 ohms ½ watt
R29 10,000 ohms ½ watt
R30 100 ohms ½ watt
R31 27 ohms ½ watt

QUESTIONS and ANSWERS

ERRORS IN A CIRCUIT

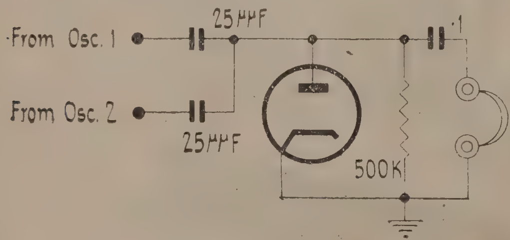
H.E.C., Christchurch, writes requesting information on errors which occurred in the circuit diagram and parts list of the Radel Allwave Eight, which was published in the November, 1947, issue of "Radio and Electronics." We have had several inquiries about these mistakes, and have pleasure in detailing them for the information of readers who may yet build this popular set, which has been built in quite large numbers.

The most important error is the one on the circuit diagram. The diode load resistor is returned to the cathode of the D.D.T. valve, V_4, which is a 6B8-G. R_{11} is the resistor referred to in the diagram, and it has wrongly been shown connected to the H.T. line, since a dot was wrongly placed there instead of a cross-over.

The errors in the parts list concern the first line for the condenser voltages, which starts "C_1, C_2, C_5, etc." The value for the whole of this row is 0.05 μf. and this was omitted, making it appear as if the line should be read on to the next, which shows a value of 100 $\mu\mu$f. This value is correct, as shown, for C_3, C_4, and C_{11}, but the whole of the previous line should have the value of 0.05 μf. placed against it.

AN UNTUNED DIODE DETECTOR CIRCUIT

H.B.C., Greymouth, writes as follows: "In the July, 1947 issue of 'Radio and Electronics' there is mention of an untuned diode detector, for use in calibration of the instrument. The circuit seems to be unknown to all those I have asked for information, so that I should be grateful if you can supply me with a suitable circuit."



Untuned detector circuit for use as a zero-beat detector. The two R.F. signals are applied to the small input condensers.

The scheme that was recommended in this article was to calibrate the home-built oscillator, using an already calibrated signal generator or service oscillator, and, as the article put it, "a simple untuned diode detector and a pair of headphones" as an indicator for finding zero beat. The circuit below can be used. The phones are placed in parallel with a diode detector circuit, which has a resistance load, and which has the outputs of the two oscillators connected into it through two small condensers. If more sensitivity is wanted, the output of the detector can be connected to the input terminal of an audio amplifier, so that the beat note can be heard in a speaker.

DESIGN FOR AN A.C./BATTERY PORTABLE

H.P., Wellington, writes: "I am interested in constructing an A.C./battery portable receiver. Do you think there would be sufficient interest to warrant your publishing a circuit, or perhaps just a discussion of the requirements, as was done for a car radio in the November, 1948, issue? I had in mind a set using miniature and/or rimlock tubes, and incorporating an R.F. stage."

This is a subject upon which we have some ideas, and, in fact, we are planning to publish such a design in readiness for the 1949 portable season. The problem is one which is more concerned with the supply of suitable tube operating voltages than anything else, and unless the components that are used by the manufacturers in building such sets are available to the retail buyer, there is not much that can be done on our side. However, we believe that the necessary dry rectifiers and special 9-volt A batteries can now be bought, not to mention suitable power transformers, so that the home constructor should have no difficulties if a suitable design is given him.

The scheme in use by the manufacturers is, briefly, to use a series connection of the 1.4 volt filaments, in such a way that the total A voltage required is 9 volts. This can be done by using a five-valve circuit, in which the output stage is a 3S4 or DL92 (which are the same things). This valve has three filament leads, so that it can be used either on 3 volts at 50 ma. or on 1.4v. at 100 ma. filament current. Here, of course, it is necessary to run it on the 3-volt connection, since this gives it the same current consumption as the remaining valves in the 1.4 volt series. It can therefore be placed in series with them, so that if there are four other valves, the total required A voltage is 9, and not 7.5. By this means, the total filament current of the set is only 50 ma. This enables the rectifier on the A.C. position to supply not only the few milliamps of H.T. current that are needed, but also the filament current as well. This is therefore possible with a power transformer which gives a rectified output of only about 75 volts at 60 ma. or so, if the miniature tubes are used. In order that the power transformer may be simplified, and also so as to have instantaneous operation on switching to A.C., a metal rectifier is used instead of a valve rectifier. The metal rectifier is also more trouble-free and can normally be expected to outlast the life of the set.

With the arrangement described above, it is apparent that fairly complicated switching will be needed in changing from A.C. to battery operation and vice versa. The operations needed are: (1) To switch the H.T line of the set from the rectifier A.C. to the B battery; (2) to switch the filaments from the D.C. output of the rectifier to the A battery; (3) to arrange, at the same time, that when switched to the battery position, no A.C. is applied to any part of the set should the user plug in the A.C. lead to the wall socket; (4) to arrange that on the A.C. position, none of the batteries will discharge through any part of the circuit; (5) to ensure that if the set is plugged in to the mains, and is working, it can be switched to battery without damage or loss of time (this applies only when the change-over mechanism includes a switch on the front panel).

Unfortunately, the required switching needs at least four poles on the switch, and two of them must be of the change-over type. If it were only a matter of the H.T. and A supply change-over switches, an ordinary toggle or rotary double-pole change-over switch would do the job, but the necessity for disconnecting the A.C. from the primary of the power transformer when the set is in the bat-

tery position, makes one more on/off, and, preferably, a two-pole on/off, essential. Thus, it is difficult to find a suitable switch unless a radio type of wafer switch is used. The contacts on these switches were not designed to carry heavy currents, as occur in the primary of the power transformer, and, although satisfactory operation might be obtained for a time, such a switch would be a potential source of trouble. This brings forward the idea of using plugs and sockets instead of switches, and this has much to commend it. The only disadvantage, and this is a minor one, is that the change-over can hardly be put on the front panel of the set, for appearance's sake. However, the scheme is sound, as long as certain precautions are taken. The obvious one is to see that any plugs used cannot carry A.C. mains voltage at any stage, and preferably that they do not even carry battery voltage. That is to say, supposing a pair of sockets and a single plug are so arranged that putting the plug into one socket gives the right connection for mains operation, and plugging it into the other puts the set on battery working. It must be arranged that when the plug is not in either socket, no voltages appear on it at all. Apart from the danger if A.C. is allowed to appear on an open plug, it is possible for its prongs to short circuit on the chassis, thereby either blowing fuses or running down batteries.

If a suitable switching arrangement has been worked out, we next come to the receiving circuit itself. There need not be any great difficulty here, except those connected with series filament operation. The chief thing to guard against is the picking up of hum by the valves, when on A.C. operation. The filament supply is filtered, because the one filter circuit smooths the supply both for filament and H.T., but some parts of the circuit are more susceptible to hum than others, and there is thus the necessity for connecting the filaments in series in the right order. For instance, the diode detector and first audio amplifier tube is particularly so, and should be placed near the earthed end of the chain. The power valve is least likely to be affected, so that the output tube can be at the end farthest removed from earth. A recommended order, starting at the earthed end, is: Detector and first audio tube, oscillator-mixer, R.F. amplifier, I.F. amplifier, and output valve.

Placing filaments in series also makes it necessary to give particular attention to the biasing arrangements, since grid circuits cannot be returned directly to earth, as the filaments are positive with respect to chassis, and this might place an unwanted negative bias on the valve concerned. For instance, in the R.F. end of the set, the valves are intended to operate with zero bias (not counting A.V.C.), and it is thus necessary for each grid circuit to be returned to its own filament. The output stage, however, needs about 7.5 volts of bias, so that the filament chain could be a convenient source of bias by returning the grid of the output tube, not to earth, but to the junction between the filaments of the first and second valves in the chain. There are numerous possibilities, and intending constructors of a set like this can have a good deal of entertainment by working out a suitable bias system, which will as far as possible make use of voltages already present in the circuit, thus doing away with the necessity of providing separate bias sources, or even of using a kind of back-bias scheme. Of course, the latter can still be used, and possesses the usual advantage that the

(Continued on page 26.)

No. 21: (a) COMPLETE CIRCUIT FOR THE EXCITER'S STRAIGHT AMPLIFIER
(b) A FINAL AMPLIFIER FOR THE ALL-BAND EXCITER

(a) Complete Circuit for the QV04/7 Amplifier in the Exciter:

In last month's issue of the "Experimenter" we were obliged, through pressure of space, to omit the promised complete circuit for the QV04/7 straight amplifier that constitutes the output stage of the exciter. It will be remembered that the circuit diagram of the exciter that we gave in "Experimenter No. 18" gave only a schematic circuit of this stage, including no metering, and showing no output arrangements. The complete circuit will be found in this issue on page 46, since it was unfortunately not possible to include it on this page owing to its size. The following description refers to this circuit.

The meter M_2 is arranged so as to be switched from the grid circuit of the QV04/7 stage to the cathode circuits of the frequency multipliers. Only a rough check is needed on the operation of the latter, since, if they are not working properly, the fact is sufficiently obvious from the resulting grid drive, or lack of it, in the straight amplifier stage. Thus, a meter which reads the combined cathode currents of all the doublers gives an excellent check on where in the multiplier chain any trouble might be. It is also a comparatively easy matter to arrange the switching. Of course, if anyone likes to put in a four-position switch instead of a two-position one and to work out the necessary switch connections, there is no reason why M_2 should not be made to read separately from the cathode currents of the multipliers, in addition to the grid current of the amplifier.

In order to put the existing scheme into operation, it is advisable to have two ranges to the meter, as well as the two positions, because, when the amplifier grid current, of about 1 ma., is to be read, we definitely want the meter to read at least half-scale. At the same time, when the three doublers are working, we need the meter to read at least 50 ma. full scale. Thus, in the original, M_2 was made a 0-1 ma. movement, which is connected to the appropriate shunts in the two positions of the switch. It is necessary to switch both sides of the meter, because the polarity has to be reversed when it has to be read grid current. Also, the method of using two shunts is advisable, because this enables a simple double-pole change-over switch to be used, while still ensuring that neither ground return is broken while the meter is in transit from one position to the other. That is to say, should the switch at any time become defective, the exciter will still keep on working normally, and all that will happen will be that the meter does not read. No values have been put in for the shunts, since these will depend on the exact resistance of the 1 ma. meter used. In the original Shunt 1 took the meter to 0-2 ma., while Shunt 2 made it read 0-50 ma. It will be noted that the lead from Shunt 2 is labelled "To cathodes of multipliers." In the original circuit, the cathodes of all three doublers were drawn as being connected to earth close to the sockets, through their individual cathode resistors. If it is decided to use M_2 to measure only the amplifier grid current, and to avoid the switching, this connection will stand. But if the scheme shown here is to be used, it will be necessary to disconnect the cathode resistors of the three EF50's from earth and run a wire from one to the other, connecting all three together. Note that the bypassing must remain where it is—i.e., the 0.002 μf. bypass condensers are still connected from the cathode pins to an earth point as close as possible to the EF50 sockets. In fact, this is even more important when the lower ends of the cathode resistors are to be lifted from ground and tied together. However, this done, the common lead is taken to the switch contact we have been discussing—the one connected to the "high" end of Shunt 2.

The connections of M_1 are quite straightforward. This meter is a 0-100 ma. instrument, and a double-pole change-over switch is used to connect it in either the plate or screen lead of the amplifier. The importance of being able to check the screen current in a stage like this has already been stressed.

It will be noted that, in addition to the metering, the full circuit shows some refinements when compared with the skeleton circuit given in "Experimenter No. 18." These include grid and screen stopper resistors, all of 50 ohms, and specially heavy decoupling in the plate circuit. The stoppers would probably be found unnecessary in some outfits, but necessary in others if the QV04/7's are not to "take off" when lightly loaded, or when not loaded at all. They are very cheap insurance against a good deal of puzzling instability which, once allowed to develop in a stage of this nature, is a first-class nuisance—and no one wants to have the bother of almost wrecking the construction of the amplifier sub-chassis in order to insert stoppers in the grid and screen circuits.

Apart from these points, there is nothing of note in the complete circuit. The output is taken from a link closely coupled to the output tank coil, L_3, as was mentioned previously. Unfortunately, in the last publication of the "Experimenter" there was a line misplaced in the coil data that were given on page 48 and made the purpose of the table not quite clear. The following paragraph should elucidate, however.

The grid and plate tank coils, L_1 and L_3, are identical, and have the number of turns stated in the top table. This also gives the form diameter, the polystyrene formers being available in two sizes. The small table below the first gave the number of turns on the input and output coupling links, which are again identical. The spacing from the tuned windings has not been given, and a little slack for movement should be allowed so that the spacing can be adjusted during the initial tuning-up of the transmitter. The fixed output links on the exciter are used because a variable coupling link will be used on the final stage input circuit, thereby allowing for varying the excitation of the latter.

(b) A 100-watt Final Amplifier to Follow the Exciter:

INTRODUCTION

The exciter that has been the subject of a number of "Experimenters" was designed, it will be remembered, so that any desired kind of final high-powered amplifier could be driven by it. That is to say, the doublers were made to operate at as low a power level as possible, feeding a low-powered straight amplifier which brings the power level on all bands up to the figure required for driving the final. The power output of the two QV04/7's is ample to drive a pair of triodes in the high-powered stage for those who prefer them to pentodes or beam tetrodes, or, simply by omitting one of the parallel tubes in the exciter output stage, the output of the exciter can be halved, and a final requiring less driving power than a triode stage can be catered for without waste. The final we are about to describe—and, of course, to recommend—uses a new Philips transmitting valve, the QQE06/40. This is a twin beam tetrode, and can be used as a direct replacement for an 829B. It uses the same socket as the latter type, and has identical electrical characteristics except in one or two important particulars, where the ratings of the QQE06/40 has advantages over the other. It has higher frequency ratings, for one thing, and can be expected to perform as efficiently at 30 mc/sec. as at 3.5 mc/sec. It should do, when it is considered that the maximum frequency for full ratings is in excess of 200 mc/sec. Physically, the QQE06/40 is rather convenient, since it has a cylindrical envelope, with no bulges at the sides, and can therefore be inserted through a shield partition base-first. The base is of the button type, and is of sintered glass, which looks very like fused quartz and has remarkable properties which make it ideally suited to use in valves for very high frequencies. The construction is very robust indeed, and the twin plate leads on top of the bulb are spaced by only 9/16 in., making the fitting of the close-spaced lines for V.H.F. work very easy. We have stressed the V.H.F. performance of this valve here for two reasons. In the first place, the efficiency at 30 mc/sec. of a valve like this one will be very much higher than 30 mc/sec. Secondly, more and more amateurs are becoming interested in working on the V.H.F. bands, so that if the transmitter used for the bands between 80 and 10 metres uses a final amplifier which is also an excellent performer up to 250 mc/sec., then many of the valve troubles associated with V.H.F. work are automatically eliminated, and, better still, real equipment economy is obtained. One does not work simultaneously on a V.H.F. band and on one of the lower ones, so that a QQE06/40 can well be used in both transmitters and plugged from one to the other as required.

To return to the job in hand, however, what special features has this new valve that make it particularly suited to an all-band transmitter such as we are discussing?

In the first place, it will be every bit as efficient on 10 metres as on 80, which is quite something in itself. Secondly, by using a double-unit beam tetrode, we finish with a power amplifier which is easy to drive, and can be made into a really symmetrical push-pull stage, since the electrodes inside the valve and their outside leads are symmetrically disposed. The push-pull stage can therefore be balanced very easily, simply by taking care in the initial lay-out stages of the design. In a push-pull stage using two separate valves, such exact symmetry cannot be obtained, because right and left-handed valves are not made. This is closely connected with the next advantage, that neutralization should not be found necessary. We are not at present in a position to dogmatize on this point, but everything we have so far done with a QQE06/40 indicates that as long as the input and output circuits are well shielded from each other, no neutralization is needed, even on frequencies as high as the 144 mc/sec. amateur band.

(Continued on page 46.)

bias is to a large extent self-compensating for changes in battery voltage throughout their life.

It should be fairly evident that a set like this will need a loop aerial, and, seeing that it can be used in the house on A.C., it would be an advantage to provide means for using a normal aerial as well, if the best distant reception is needed. This can bring further problems, the chief one being the rather limited A.V.C. control that can be put on the miniature 1.4 volt valves and the quite small signal voltages that they can handle before the R.F. part of the set starts to overload and produce distortion.

The above discussion at least brings to light some of the differences between the A.C./battery portable and the ordinary A.C. set, and, though it does not attempt to present full answers to all the problems involved, we hope that it will be found helpful by our correspondent, and others who may have similar ideas.

MODIFICATION TO ONE OF OUR EARLIER AMPLIFIERS

A.W., of Oamaru, writes as follows: "I am going to build the 'Quality 6A3 Amplifier,' described in the first issue of 'Radio and Electronics,' and would be very pleased if you would clear up a few points for me before I begin construction. (1) I intend using a P.M. speaker. What modifications would be necessary to the circuit? (2) Disregarding the question of cost, do you consider the use of a high-fidelity output transformer necessary if the amplifier is to be run in a room at an output level of only one watt or so, or would a 20-watt public address type be suitable? I will be using a good quality 12 in. speaker."

We have shortened A.W.'s questions a little, and will therefore consider the first one from scratch, as it were. The circuit referred to was originally designed for an E.M. speaker, and in order to give a low hum level, it used a two-section smoothing filter. The first section employed a choke, in order that the D.C. fed to the speaker field should be comparatively smooth, thus preventing hum through mechanical movement of the speaker cone because of the hum in the energizing current through the field winding. Thus, if a P.M. speaker is used, and the two-section filter retained, the field winding will have to be replaced either by a resistor or a further choke. The resistor would give a certain amount of extra filtering, compared with the single-section filter, but if exceptional freedom from hum is desired, as when a good speaker is used in a bass-reflex cabinet, it is definitely advisable to retain a second choke in place of the field winding. This choke can not be expected to have as much resistance as the 750-ohm field, and will probably not have more than 250 ohms or so. In this case, it will be necessary to use some additional resistance in series with the choke. This will do no harm, and will ensure that if a 385-volt-a-side power transformer is used, as originally specified, the H.T. voltage will be the same as was intended. If the extra resistance is not used, the voltage will be inclined to be too high. Another way out of the difficulty would be to use a 350-volt-a-side transformer instead, and this would really be the better solution.

With regard to the output transformer, it will be found that the use of a high-fidelity 10-watt one will not give a very noticeable improvement if the amplifier is to be run at low levels only, and that the suggestion of using a 20-watt P.A. type of transformer is therefore quite a good one. However, there are now on the market output transformers which are much better, both with regard to frequency response and distortion, than this kind of transformer, without being as expensive as the highest quality ones, which are very expensive indeed. Several makers put out intermediate transformers of this nature, and these are generally little more expensive than the 20-watt P.A. type, while possessing far better characteristics. This is the kind that we would really recommend. It will be seen that we have not disregarded cost in answering this question, and, in any case, the only real answer for any one person is to beg, borrow, or steal sample transformers of the types under discussion and try for himself, by means of listening tests, which he prefers. It is only rarely that the question of price will not enter into the choice, because it usually does so subconsciously.

PUBLICATIONS RECEIVED

"Waveforms," Vol. 19 of the M.I.T. Radiation Laboratory series. (Publishers, McGraw-Hill.)

Important as is the fundamental principle of radar, and however much the success of war-time radar development depended on basic discoveries such as the cavity magnetron, it is still true that the numerous precision applications of radar would never have been possible but for the parallel development of a multiplicity of circuits for the production of waveforms. All of us are conversant with sinusoidal waveforms, and most of us have at least a nodding acquaintance with saw-tooth and "square" waveforms, but very few realise the almost infinite variety of functions that can be performed by electronic circuitry that is designed to generate these and other waveforms, and to perform specified operations with them. This book, though written in relation to others of the M.I.T. radar series, can be regarded as a comprehensive treatment of waveforms other than sinewaves, and should be the standard work on these matters for some time to come. The approach is non-mathematical, in that it is the work of men who, as the preface points out, are primarily experimentalists rather than theorists. The emphasis is therefore on the practical side throughout, although it should not be inferred that the treatment has no sound theoretical background. Nothing could be farther from the truth, and those who have come to regard circuits for the production of pulses as simple practical devices, to which it seems a waste of time to attach theoretical considerations, will be surprised at the extent to which a straightforward approach from fundamentals can enable the performance of waveform circuits to be predicted with accuracy.

The importance of the material in this book should not be judged on the basis that its sole application is to radar. Every day techniques are being perfected, which depend on waveform manipulation for their success, and which must use a great deal of the material given by the authors of this book, even though the application may be very far removed from radar. This is a text for the general electronic engineer, and not only for those connected with radar. For instance, a large part of it is devoted to frequency multiplication and division, and to electronic counting circuits. These, and the chapters on the use of waveforms to perform mathematical operations such as multiplication, division, addition, and squaring, represent material which is of value in many different ways, and to those confronted with a wide variety of problems. To those whose interest lies in the multitude of applications for electron tubes and in the ingenious methods of circuit design, this book should be a source of delight, as well as of information.

It is very pleasing to note that there is full credit given to the British circuit designers, mainly those of TRE, who originated many of the methods described. In fact, Dr. F. C. Williams, of Manchester University, and late of TRE, was one of the joint editors, and wrote sections of the text. The numerous examples of practical circuits, complete, be it said, with all necessary values, are drawn impartially from American and British equipment, and form an invaluable portion of the material presented.

In short, "Waveforms" is a book that no one seriously concerned with circuit design can afford to be without.

The *Radio and Electronics* Abstract Service

AUDIO EQUIPMENT AND DESIGN:

Versatile Tone Control. A system for boosting or suppressing treble or bass frequencies, respectively. Provides for sharp rise or fall at 500 c/s. or other selected crossover frequency. Slope adjustable in steps of one db. per octave to maximum of 5-7 db. per octave. Overall volume level unaffected. All curves flatten off above 10 kc. and below 25 c/s. Use made of R-C networks which attenuate one group of frequencies; overall level adjusted with flat amplifiers. Basic circuits explained and complete circuit drawn. Details of construction and testing procedure.
—**Electronics (U.S.A.), December, 1948, p. 81.**

Stabilizing Gain. Chart to simplify calculations involving fluctuations in gain with and without negative feedback; amount of feedback and sacrifice in gain to obtain stability.
—**Electronics (U.S.A.), February, 1949, p. 122.**

High-fidelity Response from Phonograph Pick-ups. Discussion of basic requirements for high-fidelity gramophone reproduction. Suggestion for introduction of feedback to compensate for non-linearity in crystal pick-ups of cheaper variety. Input circuits drawn incorporating feedback. Circuits apply to three most popular types of pick-up (U.S.A.). Associated response curves shown.—**Electronics (U.S.A.), March, 1949, p. 118.**

35-watt Hi-Fidelity Amplifier. Circuit and construction of amplifier with 6L6 output. Amplifier designed for 30 watts of undistorted output. Uses specially designed output transformer in inverse feedback circuit. Transformer has separate winding for feedback voltage, which is 10 per cent. of total output. Feedback voltage is fed back to grids of output valves out of phase with incoming signal, through split secondary windings of input transformer. D.C. voltage used for valve heaters to eliminate hum.
—**Radio News (U.S.A.), April, 1949, p. 36.**

Versatile Phonograph Preamplifier. Circuit and design of preamplifier of high gain, low noise, and low distortion, with low frequency compensation. Uses 6J7 and 6SJ7 in two-valve circuit.—**Audio Engineering (U.S.A.), March, 1949, p. 14.**

Compact 6AS7G Amplifier for Residence Audio Systems. Circuit details and construction of a high-fidelity amplifier of 5-6 watts output. Built in two compact units so that existing equipment may be modernized without necessity for extra space.—**Audio Engineering (U.S.A.), March, 1949, p. 17.**

ANTENNAE AND TRANSMISSION LINES:

R-F Transmission Line Nomograms. Plotted as nomographs are ten commonly used equations for computing relationships between electrical and mechanical properties of R.F. transmission lines.—**Electronics (U.S.A.), February, 1949, p. 112.**

Flush-mounted Antenna for Mobile Application. Small annular-slot antenna is built into roof of car, since small magnetic current loop may be substituted for a vertical stub above ground without change in radiated field pattern. Discussion of fundamental principles involved. Radiation patterns given for vertical and horizontal planes of annular slot and vertical stub, respectively, measurements being taken at 150 mc. and 450 mc. Two possible feed systems suggested.
—**Electronics (U.S.A.), March, 1949, p. 115.**

Directional Antennae for A.M. Broadcasting. Details of a practical method of calculating radiation patterns for two and three-tower arrays by use of simple trigonometry and elementary knowledge of basic operation of single antenna.
—**Electronics (U.S.A.), April, 1949, p. 101.**

Parasitic-Array Patterns. Details of experimental determination of radiation patterns of several horizontal parasitic arrays. Particulars of test equipment used and method of setting up. Of interest to users of rotary beams.
—**QST (U.S.A.), March, 1949, p. 11.**

The Capital X Array for 28 mc. Details of an array consisting of four folded dipoles, suspended two-over-two and fed in phase; constructed of 300-ohm twin-lead. It is claimed that gain equals that of usual three-element array, and in two directions.—**QST (U.S.A.), March, 1949, p. 45.**

Some Ideas for Low-frequency Antennae. Article discusses the use of grounded folded-dipoles for low-frequency (amateur) bands.—**QST (U.S.A.), April, 1949, p. 28.**

CIRCUITS AND CIRCUIT ELEMENTS:

Feedback Improves Response of D.C. Amplifier. Circuit of a D.C. amplifier in which frequency response is made more linear by use of negative feedback.
—**Electronics (U.S.A.), February, 1949, p. 109.**

Heterodyne Eliminator. Circuit and details of unit for use with standard communications receivers for attenuating interference close in frequency to that of the signal being received. Principle of operation is inversion of numerical order of all frequencies each side of carrier it is desired to receive, and off-frequency difference is applied to cut-off side of asymmetrical filter. Description of unit and particulars of tuning technique. The eliminator is self-contained and coupled to receiver by small coaxial cable.
—**Electronics (U.S.A.), March, 1949, p. 83.**

Variable Frequency R.C. Oscillators. Brief discussion on subject of phase-shift oscillators. Circuit and details of practical R.C. ladder type of phase-shift oscillator to cover, in one range, from 250 to 5,000 cycles. Circuit also of switched P.S. oscillator and amplifier covering range 25 to 17,000 c/s. in six steps.
—**Electronic Engineering (Eng.), April, 1949, p. 140.**

A Stable High-voltage R.F. Power Supply. Modification to R.F. power supply intended for oscilloscopes and TV receivers to give constant output voltage. Capacitative method of feedback obviates use of tickler coil.
—**Radio News (U.S.A.), April, 1949, p. 58.**

High-speed Trigger Circuit. Circuit and description of equipment useful for cases where triggering pulses are required in a predetermined time pattern following, say, a sound, flash of light, or other physical event.
—**Electronics (U.S.A.), April, 1949, p. 85.**

Load Match Test. Two simple bridge circuits for checking impedance matching of a load which is itself an indicator of current, such as a meter or a receiver (no A.V.C.). Minimum of equipment required and method is applicable to D.C. circuits, audio and high frequency, and for balanced and unbalanced systems.—**Electronics (U.S.A.), April, 1949, p. 142.**

FREQUENCY MODULATION:

A.M. and Narrow-band F.M. in UHF Communications, Part 1. Full details of investigations undertaken by Naval Research Laboratory (U.S.A.) to enable choice to be made between above two systems of modulation for typically naval conditions. Particulars of tests made and equipment used. Respective advantages and disadvantages of each system are summarized.
—**Electronics (U.S.A.), February, 1949, p. 84.**

A.M. and Narrow-band F.M. in UHF Communications, Part 2 (concluding article). Theoretical effects compared with results of field trials. Specifications of equipment are given.
—**Electronics (U.S.A.), March, 1949, p. 102.**

INDUSTRIAL APPLICATIONS:

Precision Interval Timer. Accurate timing intervals from 0.01 to 100 seconds for industrial and control purposes. Circuit and details of a unit in which sources of error due to circuit variables are eliminated by arrangement which discharges condenser through voltage source of reversed polarity.
Electronics (U.S.A.), December, 1948, p. 88.

The Practice of Printed Circuits. An article designed to clear up misunderstandings as to possibilities and uses of printed circuit technique.
—**Electronic Engineering (Eng.), April, 1949, p. 125.**

MICROWAVE TECHNIQUES:

Microwave Discriminator Circuit. Use is made of two tuned circuits, each resonating at two adjacent frequencies. Associated rectifiers fed from these circuits have their respective outputs combined in opposition. Cavity type resonators used.
—**Electronic Engineering (Eng.), April, 1949, p. 120.**

MEASUREMENTS AND TEST GEAR:

Photoelectric Waveform Generator. Circuits and details of method of producing wide range of waveforms. Unit described generates waveshapes through use of C.R.T. and a phototube. The "Photoformer" is supplied with sawtooth voltage of chosen frequency. C.R.T. spot sweeps horizontally, phototube views screen of C.R.T. to which is applied a paper mask of contour similar to that of waveshape desired. Phototube, with amplifiers, causes spot to vary vertically in conformity with shape of mask used. Principle of operation and applications fully discussed.—**Electronics (U.S.A.), February, 1949, p. 100.**

Radio Frequency Sweep Generator. Circuit and particulars of a sweep generator, use of which makes possible the viewing of high recurrence-rate phenomena, such as R.F. output of high-frequency transmitters. Overdriven amplifier produces sawtooth sweep from a sinewave. Being prolific harmonic generator, amplifier is followed by harmonic amplifiers which produce synchronous output to drive the transmitter under observation. Unit is adaptable to high recurrence-rate pulsers also. Design problems mentioned; equipment and its use described.
—**Electronics (U.S.A.), March, 1949, p. 109.**

Versatile R.F. Meter for Ham Stations. Circuit and constructional details of small piece of equipment which has many uses, such as wavemeter, F.S. meter, modulation meter, phone monitor, and neutralization indicator. Unit is compact, in a 3 in. x 4 in. x 5 in. metal box. Use made of 1N34 selenium rectifier and copper-oxide fullwave Bridge meter rectifier.
—**Radio News (U.S.A.), April, 1949, p. 35.**

Audio Transient Distortion. Discussion on subject of audio transients. Circuit of simple pulse generator for use with C.R.T. oscilloscope for purpose of detecting distortion in audio equipment.—**Radio News (U.S.A.), April, 1949, p. 38.**

Compact Signal Injector. Circuit and lay-out of compact unit for "trouble-shooting" by method of signal injection of A.F. and R.F. signals. Uses 6SL7 valve in crystal oscillator circuit (455 k.c.). Details of method of operation.
—**Radio News (U.S.A.), April, 1949, p. 40.**

Airline Test Techniques. Outline of facilities used at La Guardia Field (N.Y.) for complete and rapid overhaul of electronic equipment used in 205 commercial aircraft and ground stations.—**Electronics (U.S.A.), April, 1949, p. 72.**

A Compact Direct-reading Audio-frequency Meter. Circuit and particulars of a unit to measure audio frequencies in range from 10 to 5,000 c/s. Circuit comprises cascade amplifier, followed by cascade squaring amplifier from which output is differentiated and the pips trigger a blocking oscillator. Oscillator is so biased that only positive-going half of oscillation reaches final triode, which is itself biased to cut-off and has microammeter, capacitor-shunted, in cathode circuit. Meter reads integrated space current which is directly a function of frequency. Unit may be calibrated from WWV tone transmissions (440 c/s.).—**Electronics (U.S.A.), April, 1949, p. 108.**

Tester for V.R. Tubes. Description of method of testing voltage regulator valves, determining voltage-current and hum-reduction characteristics.
—**Electronics (U.S.A.), April, 1949, p. 148.**

Low-distortion A.M. Signal Generator. Circuit and details of equipment suitable for adjustment of A.M. station monitors or high-quality broadcast receivers. Incorporates special features, such as combination of out-of-phase carrier voltage with partially modulated signal in cancellation amplifier to give 100 per cent. modulation; negative feedback in both audio amplifier and modulator, and exalted-carrier detector in overall feedback circuit.—**Electronics (U.S.A.), April, 1949, p. 118.**

A Sensitive Crystal-type Field Strength Meter. Circuit and construction of a simple F.S. meter using double-diode crystal unit (1N35) or two 1N34 type diodes, for fullwave rectification.—**QST (U.S.A.), March, 1949, p. 20.**

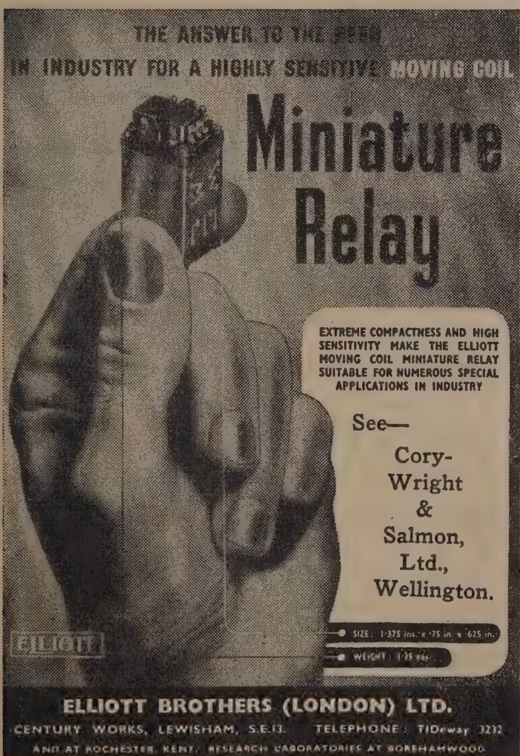
RECEPTION AND RECEIVERS:

A Modern DX Receiver. Circuit and particulars of construction of a superheterodyne receiver for amateur bands, using plug-in coils. Incorporates crystal filter.
—**Radio News (U.S.A.), April, 1949, p. 58.**

Receiver Gain Nomongraph. For rapid determination of maximum required voltage gain of a receiver, when known factors are bandwidth, noise figure, required input to detector, and antenna resistance.—**Electronics (U.S.A.), April, 1949, p. 122.**

Using the "Cascode" on 50 mc. Preamplifier using cascode circuit.—**QST (U.S.A.), March, 1949, p. 29.**

Better Results with the 522. Suggestions for improving SCR522 (U.S. surplus) receiver.
—**QST (U.S.A.), April, 1949, p. 23.**



TELEVISION:

Modern Television Receivers, Part 13. Cathode ray tubes for TV, their characteristics and performance.
—**Radio News (U.S.A.), April, 1949, p. 43.**

Television Front-end Design, Part 1. Consideration of circuits of R.F. amplifier and mixer portions of a receiver to operate in standard twelve (U.S.) TV channels. Design details are based upon use of inductive-tuning system and special consideration is given to production of high signal-noise ratio without sacrifice of gain, bandwidth, or adjacent channel rejection.—**Electronics (U.S.A.), April, 1949, p. 92.**

TRANSMISSION AND TRANSMITTERS:

Power Amplifier for the Citizens' Transmitter. Circuit and construction of two-stage power amplifier for transmitter designed to operate in citizens' band (U.S.) (**Electronics, Nov., 1947, p. 80**). Consists of two stages of Class C grounded-grid amplification, using type 2C43 valve.
—**Electronics (U.S.A.), December, 1948, p. 84.**

An All-band Mobile Transmitter. Circuit and construction of compact CW-phone transmitter. 6AK6 e.c.o.: 12AU7 doublers and 807 output; 12AT7 p.p. speech amplifier and p.p. 6K6 modulators.—**Radio News (U.S.A.), April, 1949, p. 50.**

An Inexpensive Sideband Filter. Details of filter type single sideband exciter.—**QST (U.S.A.), March, 1949, p. 21.**

Pointers in Harmonic Reduction. Practical suggestions for reducing harmonic generation in amateur transmitters.
—**QST (U.S.A.), April, 1949, p. 14.**

MISCELLANEOUS:

Radio Progress During 1948. Report based upon material from annual review of Committee of the Institute of Radio Engineers. A useful summary of development in all fields, with reference to articles and journals in which they appeared.
—**Proc.I.R.E. (U.S.A.), March, 1949, p. 286.**

High-voltage Supplies for G.M. Counters. Various methods for obtaining portable high-voltage supplies discussed and compared. Circuit of a 900-volt supply. Curves show operation under normal conditions.
—**Electronics (U.S.A.), December, 1948, p. 100.**

Design of L.P. Records. Factors determining groove width and spacing are discussed. Performance compared with 78-r.p.m. records. Brief reference to pick-up design.
—**Electronics (U.S.A.), December, 1948, p. 110.**

Hum Reduction. Detailed investigation of problem of hum. Methods explained for reducing hum arising from various sources, such as alternating magnetic fields, input circuit wiring, and heater-cathode leakage current.
—**Electronics (U.S.A.), December, 1948, p. 112.**

Melting-point Chart. Critical temperatures for metals, alloys, and ceramics used in valves. Given in degrees Fahrenheit and Centigrade.—**Electronics (U.S.A.), December, 1948, p. 118.**

Automatic Direction Finder. Circuit and details of aircraft D.F. system combining light weight, small volume, accuracy to within one degree, and instantaneous automatic operation. Special type of loop remains stationary and consists of four coils wound on cylindrical form. Special switching system enables four coil voltages to be sampled separately and in sequence, for 1/200th of a second, 50 times each second. Output is 50-cycle waveform, each cycle is divided into quarters, the amplitude of each is proportional to voltage picked up. Separate switching in sequence to an indicating meter which is calibrated to read in degrees. Details of switching system, receiver, and other components.
—**Electronics (U.S.A.), February, 1949, p. 97.**

Portable Repeating Flash Unit. Describes use of combined high-voltage power supply, energy storage capacitor, and gas-filled discharge tube to provide a unit which makes it possible to use even an ordinary box camera for short-exposure photographs. Obviates necessity for use of expensive lamps. Circuit and details of component parts of unit.
—**Electronics (U.S.A.), March, 1949, p. 74.**

Cathode Ray Tube Applications in Photography and Optics, Part 1. Details of methods for using C.R.T. to solve technical problems in photography and optics. Deals with such matters as gloss measurement on papers, shutter and flashbulb testing, measurement of ripple in light sources, detection of vibration in motion picture equipment, and other applications in these fields. —**Electronic Engineering (Eng.), April, 1949, p. 115.**

Leakage Inductance. Definition and derivation of formula for leakage inductance in transformers. Suggested use for leakage inductance in design of low-pass M-derived filters. Charts given for calculation of leakage inductance. An article of practical value to designers and builders of transformers.
—**Electronic Engineering (Eng.), April, 1949, p. 129.**

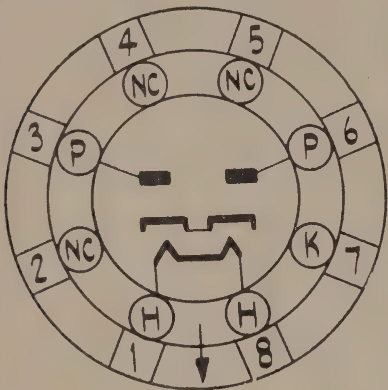
Ferro-resonance. Investigation of oscillations at sub-harmonic frequencies by combination of practical and theoretical means.
—**Electronic Engineering (Eng.), April, 1949, p. 135.**

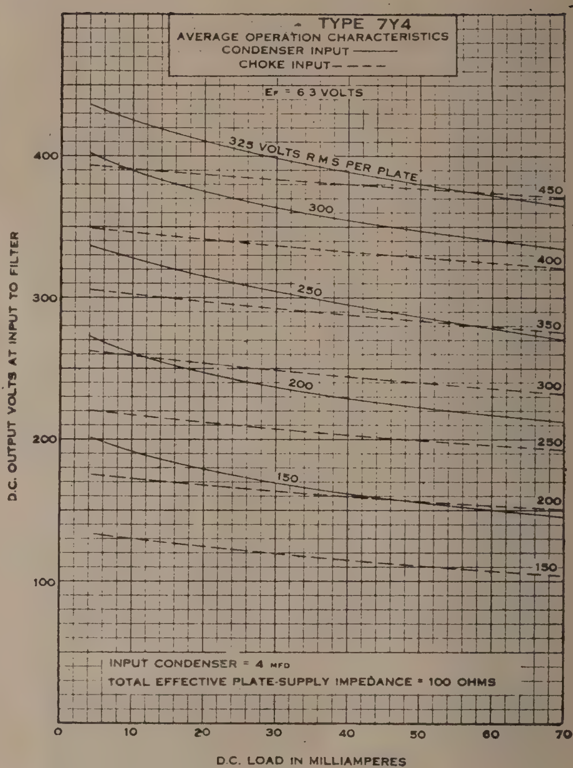
V.H.F. Link for Isolated Communities. Explanation of use of single-channel V.H.F. link, operating in 152-162 mc. (U.S.) band, to extend telephone service to difficult locations. Interconnection problems outlined. Possible functions of system are (1) service to isolated subscribers; (2) service to distant group of members who are sufficiently close to each other for use of few miles of interconnecting line; (3) toll circuits between central offices. Brief description of standard equipment used, with modifications.—**Electronics (U.S.A.), April, 1949, p. 78.**

TUBE DATA: THE 7Y4 FULL-WAVE RECTIFIER

APPLICATION

Type 7Y4 is a full-wave cathode heater type rectifier tube of lock-in construction. It is designed for service in small auto and A.C. receivers. It is similar to the older 6X5GT and 84, but is smaller physically and is considerably more rugged due to the lock-in construction. Conventional circuits such as used with older types are entirely suitable for use with this tube.





PHYSICAL SPECIFICATIONS

Base	Lock-in 8 Pin
Bulb	T9
Maximum overall length	2 25/32 in.
Maximum seated height	2¼ in.
Mounting position	Any

RATINGS

Heater voltage (nominal) A.C. or D.C.	70 volts
Heater current (nominal)	0.530 amp.
Maximum R.M.S. plate voltage condenser input	325 volts
Maximum R.M.S. plate voltage choke input	450 volts
Maxium peak inverse voltage	1250 volts
Maximum D.C. heater-cathode voltage	450 volts
Maximum peak plate current	180 ma.
Maximum D.C. output current	70 ma.
D.C. voltage drop at 70 ma. per plate	22 volts

TYPICAL OPERATION

	Condenser Input.	Choke Input
Heater voltage	6.3	6.3 volt
Heater current	0.50	0.50 ampere
R.M.S. plate voltage	325	450 volts
D.C. output current	70	70 ma.
Plate supply impedance* (Minimum per plate)	150	...... ohms
Minimum input choke value		10 henrys

*When greater than 40 μf. input filter condenser is used, it may be necessary to increase minimum plate supply impedance.

RADIO AND ELECTRONICS

Back and current numbers of "Radio and Electronics" may be obtained from—

Te Aro Book Depot, Courtenay Place, Wellington.
S.O.S. Radio Service Ltd., Queen St., Auckland.
Tricity House, 209 Manchester St., Christchurch.
Ken's Newsagency, 133–135 Stuart St., Dunedin.

Radiotron

1947 saw the release of the first Australian Miniature battery series — employing entirely new technique in valve construction—and establishing higher standards in receiver performance, at considerably reduced costs.

1948 provided the testing period during which their unquestioned reliability ensured for them a permanent place as valve complement to Australian receivers.

TODAY **A.W.V.** is justly proud to announce the release of their Australian-made range of A-C Miniatures comprising:
Types 6BE6, 6BA6, 6AU6, 6AV6

This new series will keep "set" manufacturers abreast of modern trends and make practical—

NEW DESIGN
NEW EFFICIENCY
NEW PERFORMANCE

Radiotron
VALVES

New Zealand Distributors:

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DESIGN SHEET No. 8(a) :— POWER DISSIPATED IN A RESISTANCE

SECOND CHART

Last month's Design Sheet gave the chart that can be used to find any one of the three quantities—power, current, and resistance—when the other two are known. This gives us the answer to any questions that can be solved by the use of the equation $W = I^2R$. However, when the power is wanted in terms of voltage and resistance, instead of current and resistance, the appropriate equation is $W = E^2/R$, and the chart given last month is no longer applicable. For this reason, we have printed a second chart, the one on the opposite page, which connects power, voltage, and resistance. It is just as useful as the previous one, and the two charts together can answer any questions at all where three of the four quantities—power, current, voltage, and resistance—are given. The chart is used in exactly the same way as the previous one, simply by laying a ruler across the three scales. It is arranged so that it passes through the two known values, and where it cuts the third scale is found the answer to the problem in hand.

SOME EXAMPLES OF THE USE OF THE CHART

A simple example of the use of the present chart is where it is desired to find the greatest voltage that can safely be connected across a given resistor, of known value and power rating. For example, suppose we have a 100,000-ohm resistor of 1 watt rating. What is the greatest voltage that can be connected across it without danger of its overheating?

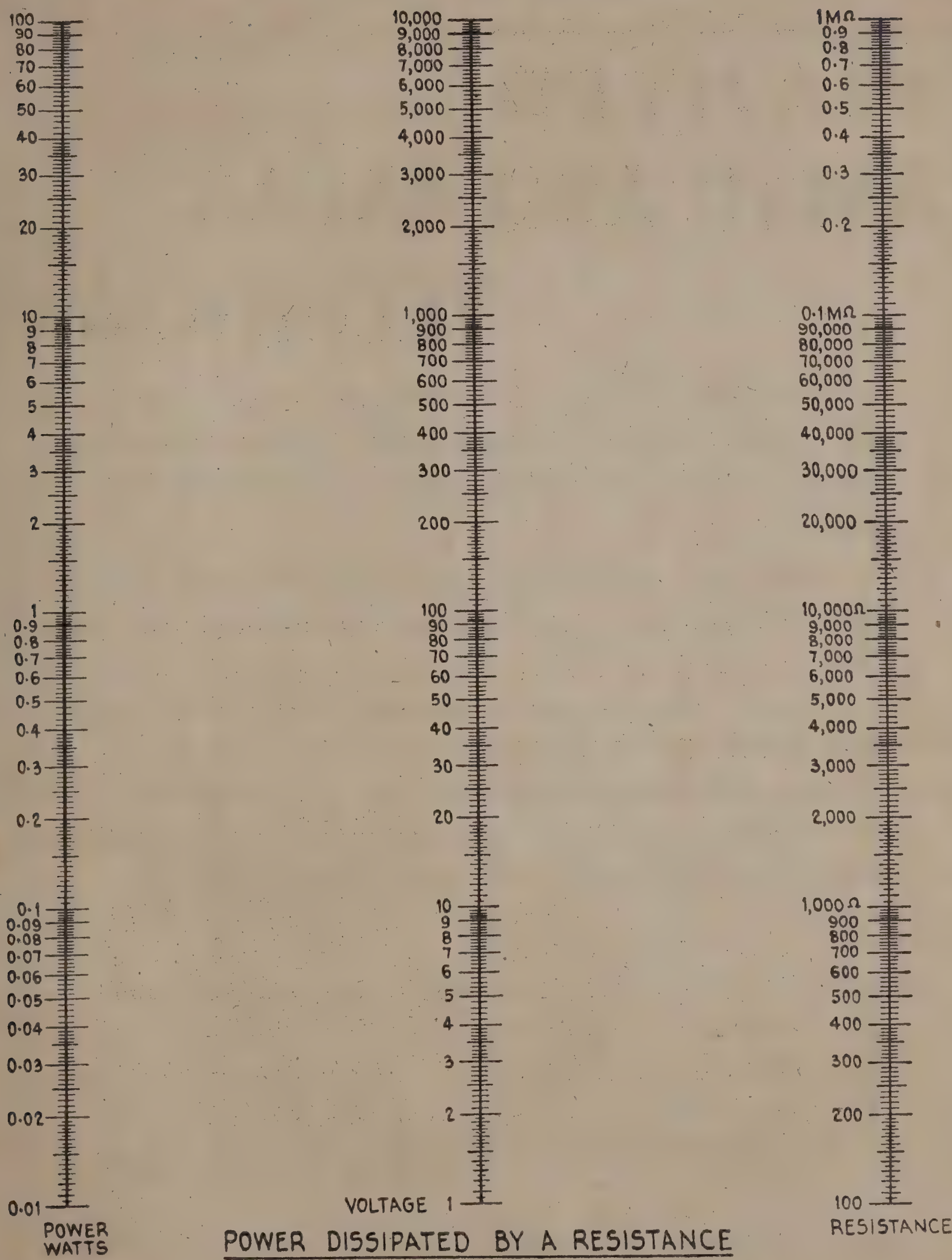
We lay the ruler across the chart so that it cuts the resistance scale at 0.1 meg. and the watts scale at 1 watt. It is then found to cut the voltage scale at 320 volts. Thus, if more than this voltage is connected across the resistor in question, the power dissipated in it will be more than 1 watt. Alternatively, it may be necessary to know the voltage that will appear across a given load resistance when a given amount of power is dissipated in it. An example of this is in the output stage of a receiver. The power valve is rated as giving 4.5 watts output, under the conditions that obtain in the set, and the load impedance of the valve is 4500 ohms. The problem is to find the voltage across the output transformer primary when the output stage is delivering its full output.

The ruler is laid across the chart from 4500 on the ohms scale to 4.5 on the watts scale. It then cuts the voltage scale at 142. The signal voltage at full output is therefore 142 volts R.M.S.

The latter problem emphasizes that the chart is just as useful for A.C. as for D.C. calculations, provided that it is realized that the voltage referred to is R.M.S. in the case of A.C. The same thing goes for the previous chart, where the current is R.M.S. current in the A.C. case. Also, it is the **impedance** in ohms that must be applied to the resistance scale in the A.C. cases. If these small points are remembered, there will be no difficulty in getting the correct answers whether one is dealing with D.C. or A.C.

A further example of the use of the chart is its application to power measurement. Suppose that we

(Continued on bottom of page 33.)



POWER DISSIPATED BY A RESISTANCE

have an audio amplifier feeding power into a 500-ohm line, and that, in order to measure the output, we place an A.C. voltmeter across the line. At maximum amplifier output, the voltage on the line is measured as 120v. Placing the ruler across the chart from 500 on the ohms scale to 120 on the volts scale, we find that it cuts the power scale at 29 watts, and this is the answer to the problem.

The New Zealand Electronics Institute (Inc.) Newsletter

EXTRACTS FROM THE ANNUAL REPORT

The annual report of the institute for the year ended 31st May, 1949, contained some interesting material, and it is pleasing to note that the institute has now acquired a legal status, according to the following paragraph:—

"**Incorporation.**—After certain amendments to the constitution had been considered by branches, the council proceeded with the matter of incorporation. Some delay occurred while a number of legal requirements were met, and the institute was finally incorporated from 9th May, 1949."

* * *

An acknowledgement of the valuable contribution made to the institute affairs by Mr. Hart also appeared in the report:

"Council desires to record the deep appreciation of the institute of the services of Mr. F. O. Hart in making possible the foundation of the institute, and pays tribute to the tremendous effort and long hours of work contributed by him over the last few years. Undoubtedly the existence of the institute is due to his initial enthusiasm and perseverance in spite of considerable disappointments and discouragement."

* * *

Members were asked to note the name and address of the new general secretary, Mr. J. H. McIvor, P.O. Box 1368, Wellington, who was appointed following an advertisement calling for applications in the daily metropolitan newspapers.

* * *

Reference was made to the active programme carried out by the four branches—Auckland, Christchurch, Dunedin, and Wellington—including some some excellent lectures.

* * *

"With incorporation completed and action taken to ensure substantial improvements in institute finances and administration, it is believed that the institute's teething pains are now over and that incoming council will be able to concentrate on greatly increasing the membership. There are ample grounds on which to base a belief that our institute can now rapidly become an important factor in the future progress of electronic endeavour in New Zealand."

* * *

The outgoing council thanked all those members who had so loyally supported the aims and objects of the institute during the past year, and asked that the incoming council have even more enthusiastic support.

* * *

PRIZES FOR RADIO SERVICEMEN'S EXAMINATION

At the May meeting of the council, approval in principle was given to the granting of a prize to the most successful candidate in the radio servicemen's examination, and the award will probably take the form of a twelve-month subscription to a technical publication.

* * *

GENERAL ANNUAL MEETING

The annual meeting of the institute was held in the Central Public Library meeting hall on Thursday, 2nd June, when approval was given the nominations of Messrs. P. C. Collier and W. L. Harrison as councillors representing combined branches.

* * *

ADMISSIONS

At a recent meeting of the council, the following members were granted increase in status as detailed hereunder:—

J. K. Scott, Christchurch, Associate Member.
C. G. Lewis, Christchurch, Associate Member.
E. A. McPhee, Wellington, Associate Member.
A. L. Partelow, Wellington, Associated Member.
H. Henry, Auckland, Associate.
W. G. Hooper, Christchurch, Associate.
W. J. Sutherland, Wellington, Associate.

* * *

DISTRICT ACTIVITIES
WELLINGTON BRANCH

Following the annual meeting of the council, the Wellington branch of the institute held its annual meeting and elected a very strong and representative committee headed by Mr. K. B. Gilby as chairman.

An interesting talk, illustrated with films, was then given by Mr. Harrison on his recent trip to Mexico, where he attended as a New Zealand representative at the international congress convened for the purpose of allocating frequencies.

* * *

OTAGO BRANCH

The usual monthly meeting of the Otago branch was held in the Jubilee Hall, View Street, on 12th

(Concluded on page 48.)

Wiring an Extension Speaker to a Radio Set or Amplifier

The apparently simple question of adding an extension speaker to a set or amplifier is one that shows unexpected difficulties when it comes to be done. Here is a way of adding an extension speaker which allows either speaker or both to be energized without loss of quality or volume.

INTRODUCTION

It appears at first sight that the business of fitting an extension speaker to a radio receiver is a very simple one that anyone can undertake. It is only when one comes to try it that it is often realized that there are any problems connected with it at all, and we have often had requests asking us to show readers the best way of doing the job. Those who have had any experience of public address systems will realize that there is more to it than simply buying another speaker and hitching it on haphazard, and will have all the answers at their finger-tips. This short article, however, is written for those who are not so fortunately placed.

In this article no attempt is made to describe all the ways in which the problem may be attacked, but rather to describe the solution to one very frequently encountered form of the extension-speaker difficulty. Because this particular problem is so often found, we hope that the information contained herein will be of use to numbers of our readers.

WHAT IS THE PROBLEM?

Suppose we have a radio set in the living-room, as so many of us have, and yet we want to do a substantial portion of our listening in another room. The obvious solution—and one that will appeal, but for the expense—is to provide ourselves with a second receiver. If for any reason we do not wish to do this, there is the alternative of using a small separate audio amplifier, fed with input signal from some part of the set. This is a good idea, too, but is expensive, and the main point in its favour is that it is possible to have as good, or even (in some cases) better, reproduction at the extension-speaker position than at the set itself. The cheapest and often the most satisfactory solution is to have simply an extension speaker, energized by the audio amplifier already in the set. This scheme has the crowning virtue of cheapness, but usually suffers from defects connected with the quality of reproduction obtainable compared with that at the set. The reason for this is that if the cost is to be kept low, then we must purchase a cheap speaker, which means a small one, and when this is decided upon it is usually bought complete with a small veneer cabinet, much smaller than the set itself, and therefore less adequate as a baffle for the speaker. However, if we are concerned about cheapness, we have no business to expect high fidelity. However that may be, we still want the best possible out of the gear we can afford, and it is here that this article comes in. The simplest ways by which the extension speaker can be connected to the set are, unfortunately, not much to be commended from the point of view of the results to which they lead. Thus, there is a strong temptation simply to take a couple of leads from the voice-coil of the extension speaker and, with the help of a simple switch, to connect them in parallel with the voice-coil of the set's speaker. If this is done, the first thing to be noticed is a very pronounced drop in volume the moment the additional speaker is switched in. This necessitates an adjustment of the volume control on the set, and if the volume that is wanted at either end is very great, it will be found that before the usual amount of sound is forthcoming, the distortion is so great that one prefers to put up with a much lower level, with less distortion. The reason for this unfortunate state of affairs is that when the extra speaker is connected, two things happen to the output valve in the set. First of all, only half the power being delivered by it goes to each speaker, so that if nothing else happened there would be only a drop of 3 db. in the level at the set. Also, if the extension speaker was similar in sensitivity to the main one, the two levels would be the same. Now, 3 db. is not a very great drop in volume, because for many people it is about the least change that can be noticed. However, this is not all. The connection of the second speaker destroys the matching which was carefully arranged by the maker of the set, so that the output valve would give the greatest possible undistorted power output into the speaker. This mismatch makes it impossible for the output valve any longer to supply as much TOTAL power as it would before the extra speaker was added, and this, added to the fact that what is available is now divided between two speakers instead of one, causes the drop in power output from the main speaker to be more than 3 db. It also causes the aforementioned effect whereby winding up the volume control will not allow the valve to give the same undistorted output power that it did before. The simple addition of the second speaker is thus not a very good idea at all.

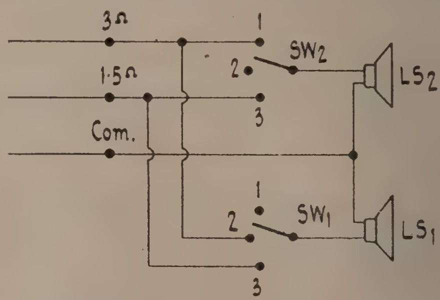


Fig. 1
The circuit arrangement used to switch from one speaker to the other, or to turn both on. The leads come from the output transformer, for details of which see text.

Our problem is therefore to do what we can to see that when the second speaker is brought into action, the power-producing capability of the output stage is not reduced. Since we are to divide the available output between two speakers, the minimum drop in volume that can occur when both speakers are to be in action is 3 db. This, as we have said, is not serious, and can be tolerated. It must be remembered, too, that, with the two speakers in action, it will at best be possible to get only half the rated power output of the set or amplifier into each

speaker. In other words, we cannot expect as much power output into each speaker as we had into only one.

WHAT CAN BE DONE

This, then, is the problem. Readers will notice that we have assumed that there will be occasion for both speakers to be on together. If this is not so, then all the foregoing objections disappear, and all we have to do on installation of the new speaker is to make sure that it has the same nominal voice-coil impedance as the one in the set. However, most users will want the system to work with either speaker on separately, and with both on at once. The solution offered here involves little work or expense, and will give this facility, at the same time ensuring that the output stage is properly matched at all times.

The circuit of Fig. 1 shows how the connections are made and what sort of switch is needed. The latter must be a double-pole three-position switch. For convenience, it is drawn on the diagram as two separate switches. It should be remembered, though, that the switches are ganged, so that both are on corresponding positions at the same time, and no other arrangement is possible.

There are three leads shown coming from the output transformer. This, as might be expected, means that the standard transformer as already in the set will have to be replaced. This, however, is the only extra expense involved in using this idea, and a small multi-match output transformer will be found quite cheap and will be satisfactory for the job. One lead we have labelled "Com.," meaning "common," while the other two leads have been marked 1.5 ohms and 3 ohms respectively. This is by way of illustration only, and is for the case where both speakers have a voice-coil impedance of 3 ohms. Thus, it is necessary to find three leads on the output transformer that can be connected in this way. This is quite easy, because all multi-catch output transformers are provided with a chart of their connections, which can be consulted to give the right answers for our purpose. We will illustrate what we mean by referring to one well-known make of transformer and its connection chart. This transformer has only three primary connections, the ends, and a centre-tap to take care of single or push-pull output valves. All juggling is done on the secondary side, which has a number of connections. The chart has a table showing a list of connections which must be used for each primary load impedance in order to get a number of voice-coil impedances at the secondary. Now, suppose we have a 6V6 output valve. This needs a load impedance of 5000 ohms. The nearest to this on the chart is 4000 ohms, so we decide to use this figure. Reference to the chart shows that to get a secondary impedance of 2.8 ohms (near enough to 3 for our purpose) we must use secondary lugs Nos. 4 and 6. Now, since we are using a three-wire switching system, and not four (i.e., one common lead for the two impedances needed), one of these lugs must be used for the common lead.

It will not be possible to parallel two secondary leads to use as the common connection, because the secondary is in the form of a tapped single winding, and doing so would short-circuit one section of the winding. Thus, we will have to put up with a match that is not quite so accurate as might be desired, but the disadvantage will be small. However, if a special transformer is being wound for the job, one can put on two entirely separate secondary windings—one to match the output valve to 3 ohms, and the other to match it to 1.5 ohms. Then, one end of each secondary can be connected to one end of the other, to make the common lead.

To continue with the story about the multi-match transformer, having found that leads 4 and 6 give a match for 2.8 ohms, we now look up the list of secondary tappings, and find that there is a row of figures for lugs 5 and 6. Going across to the column for 4000 ohms, which is the one we are working in, this tells us that if we use 5 and 6, we will get a match for 1.3 ohms. Now, this is very nearly 1.4 ohms, or half the 2.8 ohms that we are working on for one speaker only. Thus we use lugs 4, 5, and 6. Lug 6 is the common one, lug 4 we can label "3 ohms," and lug 5, "1.5 ohms." Now, all that is needed is to carry out the wiring.

A look at the circuit shows that when the switch is in position 1, the speaker labelled L.S.1 is disconnected, and L.S.2 is connected to the 3-ohm winding. On position 2 of the switch, this state of affairs is reversed, so that L.S.1 is operating, but L.S.2 is not. On the third position, both voice-coils are connected in parallel, and are connected across the 1.5-ohm winding. By this means, the matching to the power valve is preserved, and the only drop in volume will be the 3 db. accounted for by the sharing of power output. The output stage will still be capable of producing its full power.

TONE CONTROL CIRCUIT

(Continued from page 7.)

smaller it is) in parallel with R_1, and therefore decreasing its value. The effective value of R_1 is lowered, therefore, and as the frequency becomes higher, so the output becomes more nearly equal to the input voltage. The total action of the circuit is thus to produce a known loss, determined by the values of R_1 and R_2, at low frequencies; after a certain frequency is reached, and this frequency depends upon the value of C_1, the loss starts to become less and less, until at very high audio frequencies, there is no loss at all. This action is clearly one of top boosting.

As with the low-frequency circuits, the amount of boost possible depends only upon the values of the resistors, while the frequency at which the boost becomes appreciable depends only on the value of the condenser. The larger the condenser in Fig. 4 (a), the lower the frequency at which the boost starts.

Fig. 4 (b) shows how the addition of a variable resistor enables the degree of boost to be controlled. When the variable resistor is very large, C_3 is virtually out of circuit, and there is no boost at all, the output at all frequencies being the same, and of a value determined by the values of R_1 and R_2. Here again, then, the action of the variable control leaves the middle and low-frequency response unchanged, so that there is no apparent change of general volume level as the boost control is worked.

(To be continued.)

CLASSIFIED ADVERTISEMENTS

Rates are 3d. a word, with a minimum charge of 2s. Advertisements must be to hand in this office not later than the tenth day of the month in order to be published in the issue appearing about the middle of the following month.

While all care will be taken, no responsibility can be accepted for errors. Advertisements should therefore be submitted either typed or printed in block letters.

SITUATIONS VACANT

RADIO DESIGN ENGINEERS

Philips Electrical Industries of Australia Pty., Ltd., have the following vacancies for experienced radio design engineers at their modern laboratories and manufacturing plant situated in Adelaide, South Australia, which supplies the Philips requirements for the whole of Australia.

Radio Receiver Design Engineers.—Applicants must be thoroughly conversant with modern broadcast receiver design and have had four years' experience or its equivalent in design of receivers for large-scale commercial manufacture. Ability to design for economical production is essential. Diploma or Degree in Communication Engineering or Science would be an advantage.

Radio Transmitter Design Engineers.—Applicants must have a good knowledge of the design and production of radio transmitters generally, including broadcast, communications, high-frequency and mobile types, with their ancillary apparatus, and must have had at least five years' previous experience in this field. Some knowledge of aerial design, communication-type receivers, and line telephony and telegraphy is necessary. A Diploma or Degree in Engineering or Science is desirable but not essential if record of experience is satisfactory.

These are permanent staff appointments carrying holiday, sick leave, and superannuation benefits and excellent working conditions in a modern and progressive factory.

Commencing salary will be proportional to ability and experience.

Those interested are invited to communicate in the first instance with Mr. Ralph Slade, Technical Manager of Philips Electrical Industries of N.Z., Ltd., Wellington, who will be pleased to give further information in strictest confidence to intending applicants.

WANTED TO SELL

FOR SALE: Eddystone Communications Receiver; Model S.640. Apply, H. C. Harris, Lawson Street, Crofton, Marton.

PARTNERSHIP

ACTIVE WORKING PARTNER

Managerial Side

There is an opening in an established Radio and Electrical Manufacturing Business for an Active Working Partner. He will be on the Managerial side and should have experience and ability in Costing and in Wholesale and Retail Sales. Modern ideas for increasing turnover would be a decided advantage. Capital required is £2000 to £3000. This business will bear any investigation. In the first instance, write in confidence for further details to

"PARTNERSHIP,"

C/o The N. Hill-Skinner Advertising Agency Limited, 154-156 Hereford Street, Christchurch.

Make sure that your new set is fitted with a "Rola" Anisotropic Speaker. They are the first speakers to incorporate war-time research.

OUR GOSSIP COLUMN

"Radio and Electronics" recently enjoyed a visit from Mr. J. C. J. Hatton, export manager of Sterling Cable, Ltd., England, and the associated company, Cossor Radar, Ltd., England. We are always glad to welcome such visitors, as it gives us a feeling of more direct contact with English radio developments and an opportunity to discuss with overseas exporters some of the achievements of New Zealand in the same sphere of activity. We understand that Mr. Hatton was also a guest of the Swan Electric Co., Ltd., and the Clyde Engineering Co., Ltd., Wellington.

* * *

Mr. C. W. Salmon, managing director of Cory-Wright & Salmon, is at present paying a business visit to Britain.

* * *

Accompanied by his traveller, Ron Glenn, Norm Swann, of Swan Electric Co., Ltd., has recently visited Napier, where, according to all reports, he enjoyed a busman's holiday. Continuing his travels, Norm proceeded to Auckland, from whence he flew to Christchurch and Dunedin on business visits.

* * *

PUBLICATIONS RECEIVED

Through the Swan Electric Co., Ltd., Advance Components, Ltd., London, have made available a descriptive folder, in colour, fully illustrating the Advance Signal Generator, Type "E." The pamphlet also contains full technical data.

Also to hand is a colourful pamphlet entitled "Count Seven," describing the Burgoyne Seven-second Solder Gun. These are obtainable from the Swan Electric Co., Ltd.

* * *

A PRICE DECREASE

Advice is now to hand that as from 1st June, 1949, the retail selling prices of all locally manufactured general service lamps have been reduced.

* * *

RENTAL RADIOS

One of the most thriving businesses in Britain today is that of the hiring-out of radios. Before the war, business in such a field was only moderate, but now it has advanced to such an extent that one company has nearly £1,000,000 invested in radio sets.

Commenting on this position, Mr. Perring-Toms, managing director of "Radio Rentals," attributes the fact to the high price of radios (owing to the purchase tax), which has caused many people who would otherwise have purchased a radio to hire one instead.

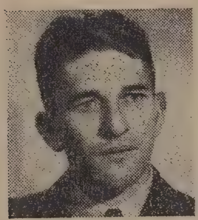
No doubt, also, the rapid development of television services has caused many people to adopt the rather erroneous attitude of "wait and see" in case television renders obsolete the conventional radio receiver.

(Continued on next page.)

EXPANSION AT PHILIPS

The continued expansion of Philips Electrical Industries of New Zealand, Ltd., has necessitated more space for the sales and service activities of Wellington branch, which distributes the company's products over Wellington, Taranaki, and Hawke's Bay provinces.

The Wellington territory branch is located in spacious premises on the ground and first floors of 30–32 Cuba Street, the radio service department occupying the first floor. Wellington branch is under the management of Noel Percival, and the service department continues under the control of George Laurie. The sales activities of the four branches are supervised by Sales Manager A. I. Webb.



Mr. N. Percival

Many new electronic lines are being marketed by the Philips organization, and it is expected that New Zealand industry will receive the full benefit of the remarkable technical advances in electronics made during and since the war, to which Philips have contributed an important part.

In order to give as widespread a technical service as possible, Philips have established technical service departments in all four branches, under the direction of Technical Manager Ralph Slade.

The head office of New Zealand Philips continues as before at Nimmo's Buildings, 2 Bond Street.

* * *

To a Wellington manufacturing company, Collier & Beale, Ltd., has gone the honour of receiving one of the largest peace-time orders for specialized radio equipment ever to be placed in New Zealand. Designed by the Post and Telegraph Department, this equipment comprises 50 mobile radio telephone base station units which, when installed, will provide a more complete radio communication service for public and possibly private utility services.

A Circuit For Getting Controllable Output Voltages From An Ordinary Power Supply Circuit

Last month we presented a circuit which used triode-connected 807's as grid-controlled rectifiers, and enabled a power supply to be built that could have its output voltage adjusted to any desired value over a wide range. The simple circuit described here enables an existing power supply to have one or more lower voltages taken from it that can also be varied over a wide range. This is done without modifying the existing circuit in any way, as it is purely an addition, which can be built separately, or wired on the power supply chassis if there is room for more valves.

INTRODUCTION

In the June issue of "Radio and Electronics," we printed a circuit which enabled a power supply to be built that would give an output voltage that could be controlled by means of an ordinary carbon potentiometer. The range of variation was quite extensive, and gave voltages as low as 45 volts and also voltages approaching the maximum that the supply could give with the transformer used. This circuit was presented because of its great usefulness to experimenters and others, where rapid control of power supply voltage is an advantage that can not easily be got by other means.

The circuit to be described here is similar in some ways to that referred to above, but is more suitable for some purposes, because it can be used as an attachment to power supplies that have already been built up, without any modification to existing wiring. The circuit can be described as an electronic voltage divider, which indicates that, like other voltage dividers, as many as we like can be placed across the power supply, each independently of the other. However, this circuit has a great advantage over normal voltage dividers in that the circuit itself draws no current from the supply other than that drawn by the device to which voltage is to be fed.

THE CIRCUIT

The circuit of a single electronic voltage divider is given in the diagram. The valve V can be almost any triode, or triode-connected tetrode or pentode. In general, however, the small triodes can be ruled out as not very useful in this sort of circuit, so that V should in general be a power valve, either large or small, according as how much current it is required to draw through it. There are other things which help to govern the choice of a valve (or valves, seeing that two or more can be wired in parallel), the main one being the allowable voltage drop through the valve. It is rarely possible to get something for nothing, and in one way the price we pay for being able to adjust the output voltage without using up current in a bleeder resistance is that it is never possible to reach the maximum voltage that the power supply will give on its own, as there must always be some voltage dropped in the valve of the voltage divider.

It will be seen that the circuit is a cathode-follower, in which the cathode load is made up, chiefly, of the device which is to be supplied with voltage. In addition, there are a 100k. resistor and a 0.5 meg. potentiometer, which are all in parallel with the load. The purpose of the fixed resistor is to provide a small load for when the normal load may be disconnected. It also helps to prevent the voltage from rising too high when the load is removed, and acts as a small fixed load when the main load is very light. The 500k. potentiometer is there to provide a controllable amount of grid bias for the valve, thereby altering its plate resistance and therefore its resistance to D.C. It thus enables the output voltage to be varied. This variation of output voltage, which is what we use the circuit for, is not independent of the current taken by the load, and so the circuit can in no sense be looked upon as a voltage regulator. It is merely a voltage adjuster, and if the load current varies, so will the load voltage. If regulation is desired, then one of the well-known regulator circuits must be used, in which the changes of output voltage are amplified and then applied to the grid of the tube which is in series with the load. However, the above circuit is a most useful one. There is no reason why two or more such adjusters should not be attached to the output of the one power supply, so long as the current drawn by all of them does not exceed the rated maximum of the supply. If a number of voltages are required from a regulated power

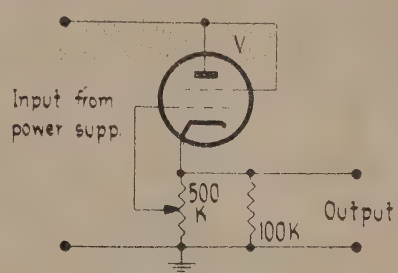


Fig. 1: The circuit of the voltage adjuster. V can be any pentode or beam tube, connected as a triode, or can be a power triode. Types 6V6, 6L6, 807, EL33, EL37, etc., can be used single or in parallel. The input is the filtered output of any normal power supply. A separate winding is advisable for the heater of the adjuster valve, and if one is not available, a small filament transformer can be used instead.

supply, the circuit of Fig. 1 can be added to it, too, and in this case the output voltages will have the advantage of being regulated before the adjusters. The circuit can be incorporated in any electronic device which has one or more voltages that need to be accurately set during use; a good example of this is in transmitting circuits, where it is essential that the screen voltage of a pentode R.F. power amplifier be set to the recommended value. This can save a considerable amount from the costs of the power supply, since there will be no need to use a low-resistance voltage divider, and because any old valve that has had its normal life can be pressed into service in this capacity. It is a great advantage to be

able to set the screen voltage rapidly to the right value after valves have been changed, for transmitting pentodes often show wide variations in screen current, with the result that installing a new tube may, in the ordinary course of events, necessitate a change in the value of the screen dropping resistor. Numerous other examples spring to mind. Those who build small receivers can make great play with this circuit as a means of getting easily the low voltages the battery valves require, and which are troublesome to arrive at otherwise. For instance, one can be used for 90 or 135 volts for the plates of 2-volt D.C. valves which are to be run from a battery-eliminator type of power supply, and another can be used to get exactly the requisite 67.5 or 45 volts that are needed for the screens. In experimental work, where low voltages are needed for safely testing a new circuit, before applying full voltage, this circuit can do the trick very nicely. For measuring resistances with an ohm-meter, where an extra voltage source has to be used, and a dry battery is not on hand, this circuit can come to the rescue once more. It can be used as a safe and trouble-free means of controlling screen voltages in a set which does not have A.V.C., as in some special V.H.F. receivers, where the old method of controlling screen voltage is used for gain control. We could go on like this for some time! It is clear that this circuit has even more applications than the grid-controlled rectifier stunt that we were writing about last month. The main reason for this is that here the original voltage of the supply is hardly affected at all. For instance, if the supply to which this circuit is attached has an output voltage of 300, for working most of the valves in a piece of gear, and a variable voltage is wanted as well, this is the circuit to use, because the adjustable voltage, or the electronic divider, leaves the original 300 volts unchanged, except for the normal regulation of the power supply.

VOLTAGES OBTAINABLE

There are so many valves that can be used in this circuit that we have made a representative selection of them and have taken figures which show the maximum and minimum output voltages of the divider when these valves are used, and with a variety of loads. It will be seen from a perusal of the tables that the lower the load resistance, and thus the higher the current drawn from the divider, the greater will be the voltage dropped in the valve, and so the smaller the output voltage that can be obtained when the power supply voltage is fixed. If less voltage drop is required, then two valves can be connected in parallel. It will usually be the case that the voltage drop is too high before the valve is passing more current than it should for its own good. However, an eye should be kept on the load current, because all the current supplied to the load has to pass through the adjuster valve, and there is no use in overloading valves unnecessarily. The tables below will form a useful guide to what can be expected from various commonly available valves in the way of voltage drop at various loads, and the maximum range of output voltage that can be obtained.

HEATER VOLTAGE FOR THE ADJUSTER VALVE

When the voltage supplied by the valve is at all high, the voltage between its cathode and heater will be very high unless a separate heater winding is used for it. If a spare winding is not available on the transformer already on the power supply, it will be necessary to install a separate filament transformer, and if a number of adjusters are to be used it would be as well to have a separate winding for each valve. One side of the filament can then be connected to the cathode of the valve, or else it can be left floating. If a directly-heated valve is used, it will be necessary, if hum is to be avoided, to centre-tap the filament and take the output from the tap rather than from one side of the filament.

PERFORMANCE TABLES

Comprehensive tables have been prepared showing the performance of many of the valve types, singly and in parallel, mentioned in the caption to the circuit diagram. These will be found on page 47.

RADIO AND ELECTRONICS

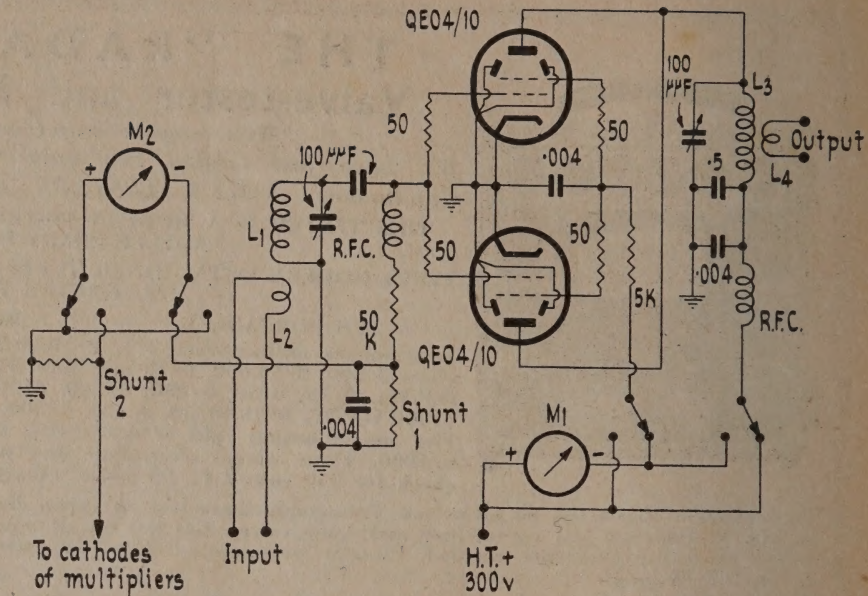
Back and current numbers of "Radio and Electronics" may be obtained from—

Te Aro Book Depot, Courtenay Place, Wellington.
S.O.S. Radio Service Ltd., Queen St., Auckland.
Tricity House, 209 Manchester St., Christchurch.
Ken's Newsagency, 133–135 Stuart St., Dunedin.

PHILIPS EXPERIMENTER

(Continued from page 25.)

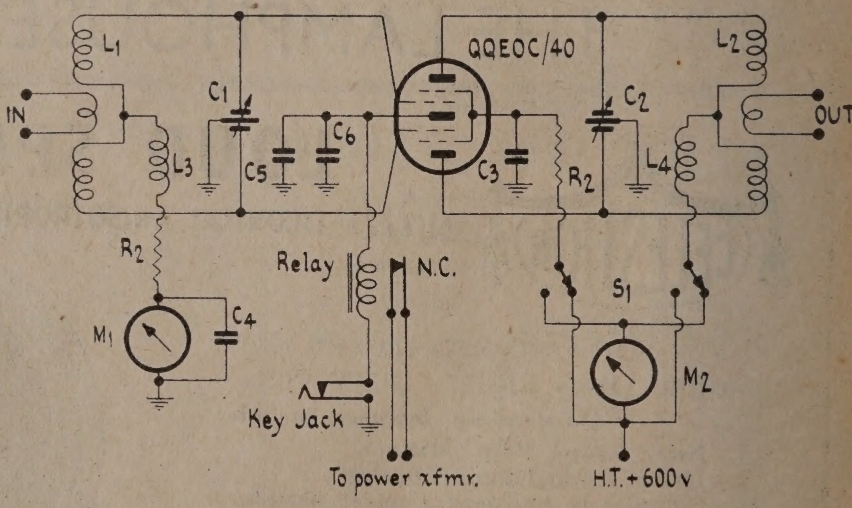
Another virtue is that of circuit simplicity and ease of adjustment. These really arise from the lack of necessity for neutralization. Incidentally, when one is talking about pentode stages and their ability to operate without neutralization, it must be remembered that if the circuits external to the valve are not shielded from each other, no amount of efficient internal shielding, as put into the valve design by the manufacturer will compensate for the resulting feedback, or will render the stage stable. Too many people seem to forget that stability is, if anything, more a function of suitable mechanical and electrical design in the associated circuit than of the valve itself, and blame anyone but themselves if a "haywire" version, or a badly-designed stage, fails to be stable.



Above: Full circuit of the QE04/10 or QV04/7 straight amplifier. This is discussed in the text.

THE FINAL'S CIRCUIT

As can be seen from the diagram, the circuit is conventional in every way. A quite normal push-pull arrangement is used. Metering is provided in the grid circuit to give constant monitoring of grid current, and a further meter is connected in the plate and screen circuits with a switch enabling either plate or screen current to be read independently of each other. A keying jack is connected in the cathode, and in addition a relay is shown with operating coil in series with the cathode circuit. The contacts of this relay are externally connected in series with the primary of the H.T. transformer which supplies the plate voltage for the final, so that this one acts as an overload relay. Should the final, for any reason at all, pass more current than a certain figure determined by the sensitivity of the relay, the latter closes, opening the contacts, normally closed, that complete the 230-volt supply connection to the H.T. transformer. This scheme is well worth while, and even the first cost of the relay can readily be offset against the possibility of damaging beyond repair a valve which, by its very nature, cannot be expected to be cheap to replace. This method of providing protection is better than connecting the contacts of the overload relay in series with the cathode of the valve, because when this is done, it is difficult to prevent arcing at the contacts when the relay operates and breaks the current.



The circuit of the final amplifier, full values, and coil data will be given in the next instalment of the "Experimenter," together with photographs of the finished amplifier.

The overload relay's operating coil fulfils another useful function in that it acts as a cathode bias resistor at the same time. This allows the relay coil to provide a substantial portion of the necessary grid bias and to hold the plate current to a reasonable value in case the excitation should fail. A further advantage of this is that loss of excitation will not be a sufficient reason for the overload relay to trip, and only gross overloads for other reasons will be called upon to work the relay. We thus have a double protection against damage to the valve.

(To be continued.)

CONTROLLABLE POWER SUPPLY

(Continued from page 44.)

No. of valves: 1 — VALVE TYPE 807						
Input voltage	450	450	450	450	450	450
Load resistance (kilowatts)	1	2.5	5	10	30	—
Output voltage: Maximum	—	—	375	390	415	420
Minimum	—	—	49.5	52	55.5	59
Output current in ma. at maximum output voltage	—	—	75	39	13.8	—
No. of valves: 1						
Input voltage	400	400	400	400	400	400
Load resistance (kilowatts)	1	2.5	5	10	30	—
Output voltage: Maximum	—	290	320	340	360	390
Minimum	—	41	44	46	49.15	52
Output current in ma. at maximum output voltage	—	116	64	34	12	—
No. of valves: 1						
Input voltage	300	300	300	300	300	300
Load resistance (kilowatts)	1	2.5	5	10	30	—
Output voltage: Maximum	165	210	235	245	265	285
Minimum	29.5	30	32.5	34	37	39
Output current in ma. at maximum output voltage	165	89	47	24.5	8.8	—
No. of valves: 2						
Input voltage	450	450	450	450	450	450
Load resistance (kilowatts)	1	2.5	5	10	30	—
Output voltage: Maximum	—	—	385	410	430	448
Minimum	45	50	54	56	59	61
Output current in ma. at maximum output voltage	—	—	78	41	17	—
No. of valves: 2						
Input voltage	400	400	400	400	400	400
Load resistance (kilowatts)	1	2.5	5	10	30	—
Output voltage: Maximum	—	310	340	355	380	395
Minimum	40	45	48	50	52	54
Output current in ma. at maximum output voltage	—	124	88	36	13	—
No. of valves: 2						
Input voltage	300	300	300	300	300	300
Load resistance (kilowatts)	1	2.5	5	10	30	—
Output voltage: Maximum	185	225	245	265	280	295
Minimum	30	33	36	37	39	41
Output current in ma. at maximum output voltage	185	92	49	27	9.3	—
No. of valves: 1 — VALVE TYPE 6L6						
Input voltage	400	400	400	400	400	400
Load resistance (kilowatts)	1	2.5	5	10	30	—
Output voltage: Maximum	—	225	300	335	370	395
Minimum	37	43	46	50	53	56
Output current in ma. at maximum output voltage	—	90	60	34	14	—
No. of valves: 1						
Input voltage	300	300	300	300	300	300
Load resistance (kilowatts)	1	2.5	5	10	30	—
Output voltage: Maximum	120	185	225	250	275	295
Minimum	27	32	35	38	41	43
No. of valves: 1						
Input voltage	250	250	250	250	250	250
Load resistance (kilowatts)	1	2.5	5	10	30	—
Output voltage: Maximum	100	145	180	205	225	240
Minimum	22	24	28	30	33	35
Output current in ma. at maximum output voltage	100	58	36	21	7.5	—
No. of valves: 2						
Input voltage	400	400	400	400	400	400
Load resistance (kilowatts)	1	2.5	5	10	30	—
Output voltage: Maximum	—	290	340	360	385	400
Minimum	—	45	47	50	53	56
Output current in ma. at maximum output voltage	—	110	68	36	13	—
No. of valves: 2						
Input voltage	300	300	300	300	300	300
Load resistance (kilowatts)	1	2.5	5	10	30	—
Output voltage: Maximum	170	220	250	270	285	300
Minimum	29	34	36	38	41	43
Output current in ma. at maximum output voltage	170	88	50	27	9.5	—
No. of valves: 2						
Input voltage	200	200	200	200	200	200
Load resistance (kilowatts)	1	2.5	5	10	30	—
Output voltage: Maximum	100	135	155	170	185	200
Minimum	19	22	23	25	27	29
Output current in ma. at maximum output voltage	100	54	31	17	6.2	—

N.Z.E.I. NEWSLETTER

(Continued from page 35.)

May. After the general business of the meeting, a lecture was given by Mr. Faulkner on "Fluorescent Lighting." This lecture was of exceptional interest and was keenly followed by all present. At the conclusion of the lecture, a vote of thanks was proposed by Mr. Symmonds and was carried with applause. Mr. Faulkner also supplied a complete set of notes for inclusion in the minutes of the meeting.

ATTENTION, AUSTRALIAN READERS!

We are pleased to advise our Australian readers that arrangements have been made whereby annual subscriptions and copies of back numbers of "Radio and Electronics" may be obtained from

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